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SURVEY ON THE OCCURRENCE OF NEMATODE-TRAPPING FUNGI IN DIFFERENT SOIL HABITATS OF UTTAR PRADESH, INDIA

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ABSTRACT

Nematode-trapping fungi (NTFs) are an important group of soil microorganisms that can suppress the population of nematodes. It has the unique ability to capture, infect and kill the nematodes. The interest in studying these fungi arises from their potential use as biological control agents for plant- and animal-parasitic nematodes. NTFs are ubiquitous in nature and have been reported to present in agricultural, horticultural, and forest soil. The aim of present study was to isolate and identify the various NTFs to explore the distribution of nematode-trapping fungi for their natural conservation and to use as potential biocontrol agents against the plant-parasitic nematodes. Three hundred soil samples were collected from the leaf litter beneath the various fruit plants, trees, agricultural and vegetable field's rhizosphere from thirty different selected sites of Uttar Pradesh during Sep. 2021 to March 2022. By using the soil plating method, eleven different species of NTFs were recorded and among which *Arthrobotrys oligospora* was observed with maximum recovery per cent in both leaf litter of fruits and other tree soil (42.7%) as well as from different agricultural and vegetable field soil (15.3%). Other NTFs were *A. conoides*, *A. musiformis*, *A. eudermata*, *D. brochopaga*, *D. phymatopaga*, *D. dactyloides*, *D. gephyropaga*, *A. superba*, and *A. cladodes*. This study evident the richness of NTFs was higher in leaf litter soil than agricultural and vegetable field soil.
***Keywords*:** Nematode-trapping fungi, Survey, Plant parasitic nematodes, Soil habitats

Introduction

Nematode-trapping fungi are a group of micro fungi that develop various types of trapping devices to trap and parasitize nematodes (Drechsler, 1937; Drechsler, 1941; Ahrén and Tunlid, 2003; Meerupati *et al*., 2013; Kumar *et al*., 2005a; Andersson *et al*., 2014; Su *et al*., 2015; Kumar *et al*., 2015; Kumar, 2017; Kumar and Gauda, 2018; Kumar *et al*., 2021). Nematode-trapping fungi are ubiquitous in nature and have been reported to be present in agricultural, horticultural, and forest soil (Singh *et al*., 2005a; Singh *et al*.,2005b; Kumar and Singh, 2006a; Kumar and Singh, 2006b; Singh *et al*., 2007; Kumar *et al*., 2010; Kumar and Gauda, 2018). They could form trapping structures to capture and kill nematodes in all habitats, to utilize nematodes as a source of nutrients. Therefore, nematode-trapping fungi can be exploited in agriculture as potential biocontrol against plant-parasitic nematodes (Chattopadhyay and Singh, 2015). The presence of nematode-trapping fungi in various types of ecological, geographical regions, and different habitats throughout the world were studied by several workers (Duddington, 1951; 1954; Gray 1987; Dackman *et al*., 1992; Su *et al*., 2007; Mo *et al*., 2008; Saxena, 2008). Nematode- trapping fungi have been reported from various ecological niches but being most frequent in soils with higher content of organic matter, especially in decaying plant litters, followed by cultivated soil, compost, and soil associated with moss (Saxena, 2008). In present study, we explored the distribution of nematode-trapping fungi for their natural conservation and better utilization as potent biocontrol against these fungi in future use.

Materials and Methods

Collection of samples

Three hundred soil samples were collected from the litter soil beneath the tree plants and agricultural and vegetable field rhizospheric soil from thirty different selected sites of Uttar Pradesh (Table-1 and 2) during Sep. 2021 to March 2022. 50 g of samples were collected from different locations of each plant root rhizosphere containing some part of soil and decaying leaf materials and separately taken in polythene bags. From each location, 10 samples of 50 grams soil were collected and were double sealed to maintain soil moisture and brought to the laboratory for the isolation of nematode trapping fungi by the method described by Duddington (1955) and Singh *et al*. (2004). Soil samples were thoroughly mixed before use for soil plating. Sterilized maize meal agar medium (maize-20 g, agar-20g and distilled water- 1000 ml) cooled near the solidification was poured into several sterile Petri dishes to cover nearly 2/3rd area of a plate. After solidification of maize meal agar medium, melted and cooled rabbit dung agar (rabbit dung pellets -50 g, agar-20g and distilled water-1000 ml) medium was poured into these Petri dishes to cover remaining area. One gram of each soil sample was sprinkled over the poured medium into Petri dishes and were incubated at room temperature (25-30 ^{0}C).

Identification and quantification of percent recovery of nematode- trapping fungi

Incubated Petri dishes containing samples from each ecological niche were observed routinely after 4 days of incubation for the occurrence of nematode-trapping fungi under stereoscopic binocular microscope. Nematode trapping by various types of adhesive or non-adhesive traps was observed and spores formed on the single conidial heads near the trapped nematodes were picked under stereoscopic binocular microscope with a sterilized fine needle and transferred into the fresh corn meal agar medium separately for isolation of single species of nematode-trapping fungi. Morphological characters of the isolated fungi were identified by morphological descriptions given by Drechsler (1937) and Cooke and Godfrey (1964). The observations were recorded based on the occurrence of total number of species in all samples of different rhizospheric habitats/ sites and percent occurrence of different types of nematode trapping were calculated. Pure culture of different species of nematode trapping fungi was done picking the conidia from individual conidial heads by using sterilized fine needle and dragged lightly across into corn meal agar medium. For identification of different species of nematode trapping fungi, conidial size, shape, number of septa in conidia, conidiophore size, branching pattern; hyphal width, type of hyphal nets, etc., were measured and compared with the original description given by Drechsler (1937) and Cooke and Godfrey (1964).

Results and Discussion

Observations of agar plates inoculated with soil samples from leaf litter of fruit and other tree soils from different locations, recorded 11 species of nematode-trapping fungi forming various type of trapping structures **(Fig. 1, a and b)**. Among the nematode- trapping fungi, *Arthrobotrys oligospora* was recorded with maximum frequency (42.7%) followed by *A. conoides* (31.1%), *A. musiformis* (29.3%), *A. eudermata* (26.7%), *D. brochopaga* (24.7%), *D. phymatopaga* (20.7%), *D. dactyloides* (15.7%). *D. gephyropaga* (12.7%) and *A. superba* (15.3%) respectively. *A. cladodes* was recorded with minimum frequency in soil samples collected from leaf litter of fruit and other tree soils (Table - 1). During isolation of nematode trapping fungi from agricultural and vegetable field soil from different locations, comparatively low percent of nematode- trapping fungi were recorded from 150 composite samples collected from 15 different locations (Table-2). Among the nematode-trapping fungi recovered from, agricultural and vegetable field soil, *Arthrobotrys oligospora* frequency was only (15.3%) followed by *A. superba* (13.3%) *A. conoides* (12.7%%), *A. musiformis* (11.3%), *D. brochopaga* (11.3%), *A. eudermata* (10.0%), *D. dactyloides* (10.0%). *A. cladodes* (8.0%), *D. gephyropaga* (4.0%). *A. thaumasia* and *D. phymatopaga* was found absent in agricultural and vegetable field soil of different locations (Table-2). It is evident from results that species richness of nematode- trapping fungi and percent occurrence of nematode trapping fungi was higher in case of decaying leafy soils beneath fruit plants and trees (10.7-40.7%) with a total of 9-11 different species of nematode-trapping fungi in each location soil (Table-1) in comparison to agricultural and vegetable rhizospheric soil with 4-9 species of nematode-trapping fungi with a low percent occurrence (4.0-15.3%) occurrence (Table-2). In the habitat of leaf litter soil beneath the different fruit and tree plants, adhesive network forming fungi namely *A. oligospora, A conoides*, *A. musiformis* was found in higher frequencies (26.7%-40.7%) in comparison to other adhesive network forming fungi namely *A. thaumasia A. superba, A. cladodes and D. gephyropaga* (12.7 to17.3%). The constricting ring forming fungi *D. brochopaga* was appeared in higher frequency (24.7%), followed by *D. dactyloides* (15.3%). One adhesive knob forming species namely *Dactylellina phymatopaga* with 20.7% and one adhesive branches forming species namely *Dactylellina gephyropaga* with 12.7% occurrence were recorded in leaf litter soil samples of fruit and tree plants. (Table 1). In the habitat of leaf litter soil, the species richness is also very high with the occurrence of eleven different species of nematode trapping fungi (Table-1). Nematode trapping fungi is much more diverse in leaf litter soil of fruit and various tree plants in comparison to agricultural and vegetable field soils. In the agricultural and vegetable field soil, the species richness is much lesser with a count of maximum recovery of 9 species of nematode-trapping fungi. The population of nematode trapping fungi in agricultural and vegetable field soil is mainly dominated by *A. oligospora* with 15.3% occurrence frequency followed by *A. superba* (13.3%), *A. conoides* (12.7) (Table-2) while, the frequency of constricting ring forming fungi *Drecslerella brochopaga* and *D. dactyloides* was found in less amount (10.0 -11.3%). It is evident from the result that the percent occurrence of nematode trapping fungi is drastically reduced in agricultural and vegetable soil with a lesser species richness. Thus, the presence of species of nematode trapping fungi in agricultural and vegetable soil is much lesser in comparison to decaying leaf litter soil of fruit and tree plants.

The richness of species of nematode-trapping fungi in soil of various habitats is mainly depend upon the presence of soil nematodes which act as nutrient source for multiplication of these fungi in different soils. The higher recovery of various species of nematode trapping fungi in leaf litter soil beneath the fruit and tree plants might be due to the higher population density of free-living nematodes than that of agricultural and vegetable crops soil. The diversity in the occurrence of nematophagous fungi from different habitats in various countries was also reported by different workers (Gray, 1987; Persmark *et al*., 1996; Kerry and Hammrick, 2002; Saxena, 2008, Kumar, 2024a and b). Duddington (1962) reported that nematode- trapping fungi grow well in the soils having good quantity of organic matter. Thus, they are more frequently encountered from leaf litter, decaying woods, dung and freshly decaying foliage etc. (Duddington, 1940, 1962; Soprunov, 1958; Drechsler, 1937, 1941; Shepherd, 1955; Maupas, 1915). The highest diversity has also been recorded form the deciduous leaf litter and coniferous leaf litter, coastal vegetation and permanent pasture or temporary agriculture pasture (Duddington, 1951). Similarly, the highest population density of these fungi was recorded in soil associated with decaying leaves followed by cultivated soil, compost and soil associated with moss (Saxena, 2008). Our findings are more or less similar with the previous studies on distribution pattern of nematophagous fungi in agricultural, horticultural and forest soil (Kerry and Hammrick, 2002; Persmark et. al., 1996; Singh *et al*., 2014). It is evident from the results that nematode trapping fungi are more abundant in the leaf litter soil of fruit and tree plant because of the good soil health and organic consent due to continuous leaf defoliation in soil beneath the fruit and tree plants which is undoubtedly lacking in agricultural soil. Thus, the soil beneath the fruit and tree plant could be better utilized for conservation and exploitation of potential species of nematodes trapping fungi to understand the biological control phenomenon and their possible use in the biocontrol of plant parasitic nematodes in agricultural and horticultural soil.

Table 1: Percent occurrence of different nematode- trapping fungi from leaf litter soil beneath different tree from different location of Uttar Pradesh.

Locations/ Habitat	*A. oligospora*	*A. conoides*	*A. musiformis*	*A. thaumasia*	*A. eudermata*	*D. brochopaga*	*D. dactyloides*	*D. gephyropaga*	*D. phymatopaga*	*A. cladodes*	*A. superba*	TNF
Aonla orchard soil Banda	4	3	3	2	3	2	2	1	2	2	2	**11**
Aonla orchard soil Faizabad	5	3	4	2	3	2	1	_	4	1	1	**10**
Aonla orchard soil, BHU varanasi	4	3	3	1	4	2	2	2	2	_	2	**10**
Jhanshi aonla orchard soil	5	3	3	1	3	3	1	-	2	_	1	**9**

Aonla orchard soil, ANDUAT, Faizabad	4	4	2	1	2	2	2	1	2	1	1	**11**
Banyan tree soil, Varanasi	6	3	3	1	3	3	2	1	2	2	2	**11**
Banyan tree soil, Jhansi	5	3	4	2	2	2	2	2	2	1	2	**11**
NBFGR, Aonla litter soil	4	4	2	1	2	3	1	3	1	1	2	**11**
Banyan tree soil, Ghazipur	4	3	3	2	2	2	2	1	2	1	2	**11**
Guava orchard soil, Ghazipur	3	3	2	2	3	3	1	1	1	1	2	**11**
Guava orchard soil, Banda	4	4	3	2	3	2	1	2	2	1	1	**11**
Guava orchard soil ANDUAT, Ayodhaya	3	3	3	2	2	3	1	1	1	2	1	**11**
Guaave orchard soil varanasi	4	3	3	2	2	2	1	_	2	1	1	**10**
Sahtoot leaf litter soil	5	2	4	2	3	3	2	2	3	1	2	**11**
Neem tree litter soil Banda	4	3	2	3	3	3	2	2	3	1	1	**11**
Total samples yielded the individual species of NTF (out of 150 samples)	**64**	**47**	**44**	**26**	**40**	**37**	**23**	**19**	**31**	**16**	**23**	
Recovery of individual species (%) of NTF (out of 150 samples)	**40.7**	**31.3**	**29.3**	**17.3**	**26.7**	**24.7**	**15.3**	**12.7**	**20.7**	**10.7**	**15.3**	

Table 2: Percent occurrence of different nematode- trapping fungi from agricultural and vegetable crop soil from different location of Uttar Pradesh.

Locations/ Habitat	*A. oligospora*	*A. conoides*	*A. musiformis*	*A. thaumasia*	*A. eudermata*	*D. brochopaga*	*D. dactyloides*	*D. gephyropaga*	*D. phymatopaga*	*A. cladodes*	*A. superba*	***TNF***
Agricultural rhizospheri soil BHU	1	1	2	-	1	-	0	1	-	-	2	6
Agricultural rhizospheri soil , ANDUAT, Faizabad	1	2	1	-	2	-	-	-	-	-	1	5
Agricultural rhizospheric soil, Ghazipur	2	1	2	-	1	-	-	1	-	-	2	7
Agricultural rhizospheri soil , Mau	1	1	-	-	1	-	-	0	-	-	1	4
Agciicultural field soil Ballia	2	1	-	-	-	-	-	1	-	-	1	4
Agricultural field soil, Hamirpir	1	1	2	-	-	-	-	-	-	-	1	4
Agricultural field soil Jhanshi	1	2	1	-	1	-	-	-	-	-	-	4
IIPR, Kanpur field soil	2	1	1	-	1	1	0	-	-	-	-	5
Vegetable research form BUAT, Banda	1	2	1	-	1	3	3	1	-	1	1	9
BHU root knot infested soil	2	2	1	-	1	3	2	-	-	2	2	9
IIVR root knot infested soil	3	1	1	-	2	2	2	-	-	3	2	8
Agciicultural field soil Sultanpur	1	-	2	-	2	1	0	1	-	1	2	7
Root knot infested soils, Ghazipur	1	1	1	-	1	2	2	-	-	1	1	8
Root knot infested soil, BHU	2	1	1	-	1	2	3	-	-	2	2	9
Agricultural field soil , Kanpur	2	2	1	-	-	3	3	-	-	2	2	7
Total samples yielded the individual species of NTF (out of 150 samples)	**23**	**19**	**17**	**0.0**	-	**17**	**15**	-	**0.0**	**12**	**20**	
Recovery of individual species (%) of NTF (out of 150 samples)	**15.3**	**12.7**	**11.3**	**0.0**	**10.0**	**11.3**	**10.0**	**4.0**	**5.3**	**8.0**	**13.3**	

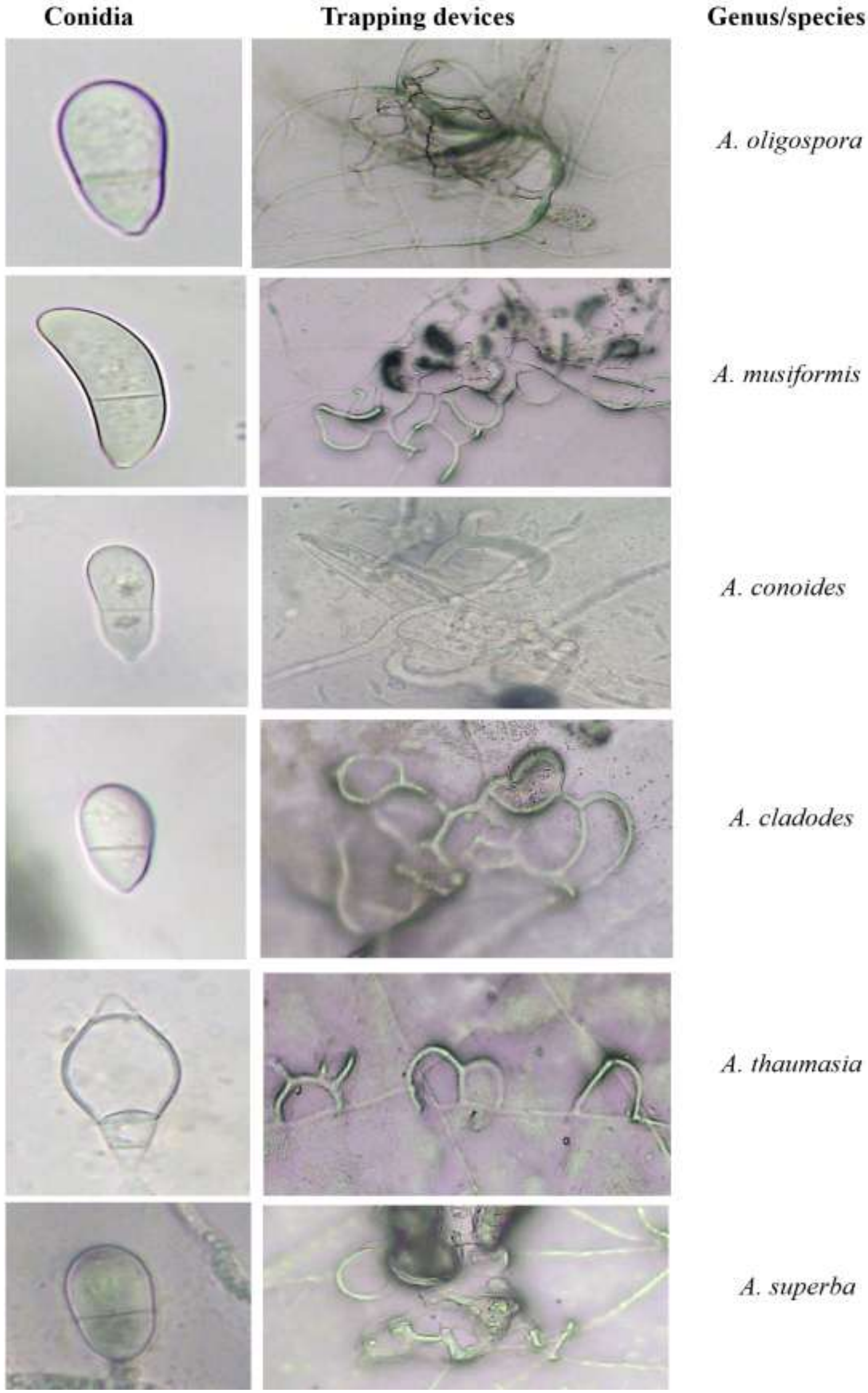

Fig. 1 (a) : Morphology of conidia and trapping devices (three-dimensional adhesive network) of different nematode-trapping fungi.

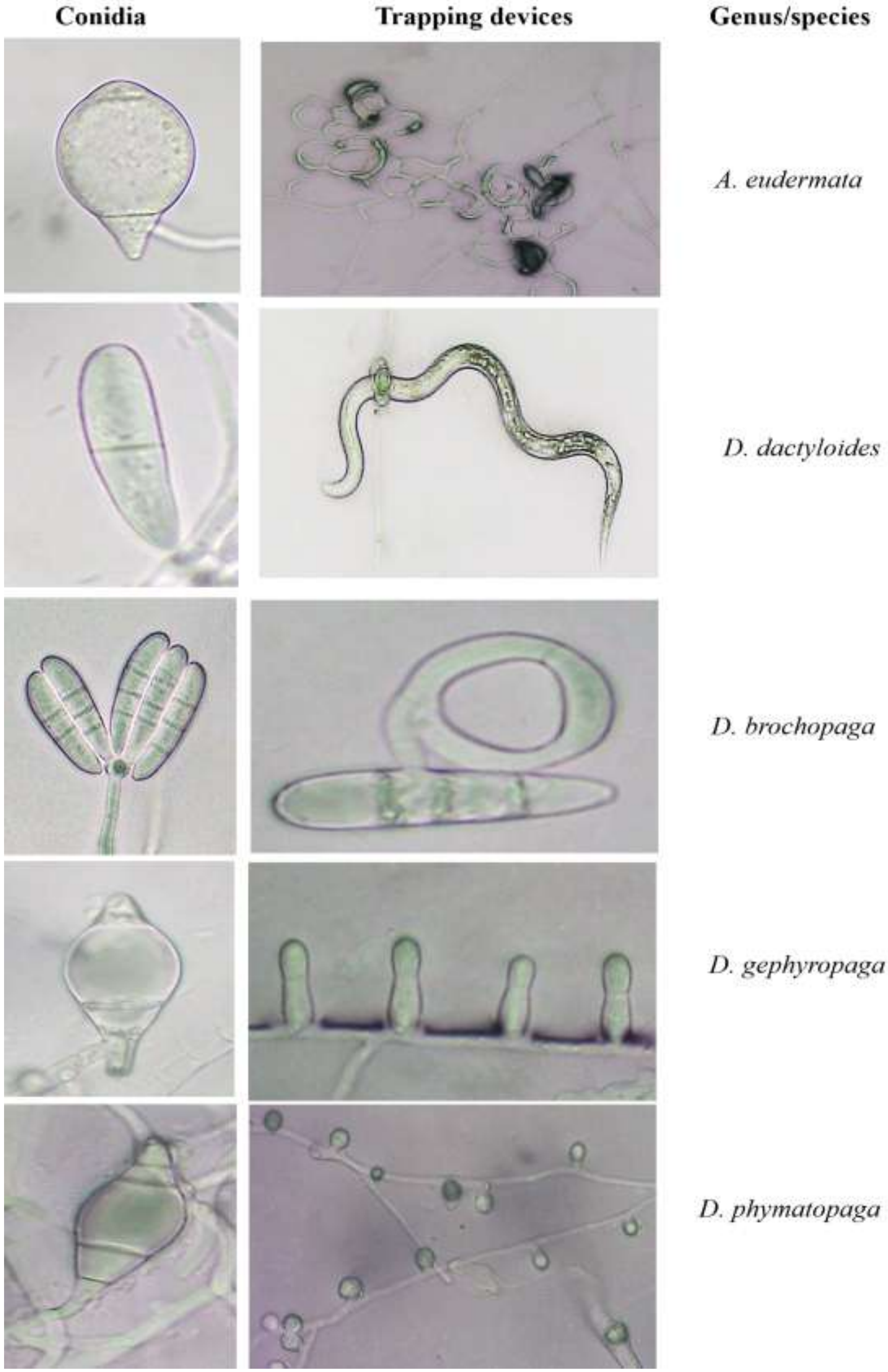

Fig. 1 (b) Morphology of conidia and trapping devices (three -dimensional adhesive network, constricting rings, Adhesive branches, adhesive knobs) of different nematode-trapping fungi.

Conclusion

The present study was aimed to search the ideal habitats for dominance of nematode-trapping fungi for their collection and natural conservation for future use in the biological control of plant parasitic nematodes. The observations of present study revealed that leaf litter soil beneath the fruits and trees are highly rich in potential species of nematode-trapping fungi due to abundant organic matter than the agricultural and vegetable field rhizospheric soil.

References

Ahrén, D., Tunlid, A. (2003). Evolution of parasitism in nematode-trapping fungi. *J Nematol*. **35**, 194–197.

Andersson, K-M., Kumar, D., Bentzer, J., Friman, E., Ahrén, D. and Tunlid, A. (2014). Interspecific and host-related gene expression patterns in nematode-trapping fungi. BMC Genom. **15**, 968.

Chattopadhyay, A., & Singh, R. K. (2015). Biodiversity and ecological distribution of nematophagous fungi. *Microbial biodiversity: a boon for agriculture sustainability. Daya Publishing House, New Delhi*, 278-305.

Cooke, R.C., Godfrey, B.E.S. (1964). A key to the nematode destroying fungi. *Trans. Br. Mycol. Soc.* **51**, 555–561.

Dackman, C., Jansson, H.B., Nordbring-Hertz B.(1992). Nematophagous fungi and their activities in soil. In: *Soil Biochemistry*. (eds. G. Stotzky and J.M., Bollag), Marcel Dekker, New York, 1992; 95-103.

Drechsler, C. (1937). Some hyphomycetes that prey on free-living Terricolous nematodes. *Mycologia.*, **29**, 447-552.

Drechsler, C. (1941). Predacious fungi. *Biol. Rev. Camb. Philos. Soc.* **16**, 265–290.

Duddington, C.L. (1955). Fungi that attack microscopic animals. *Bot. Rev.* **21**, 317-339.

Duddington, C.L. (1954). Nematode destroying fungi in agricultural soils, *Nature*, **173**: 500-501.

Duddington, C.L. (1962). Predaceous fungi and the control of eelworms. In: Viewpoints in Biology. (ed. by J. D. Carthy and C. L. Duddington). London: Butter- Worth. **1**, 151-200

Duddington, C.L. (1940. Predacious fungi. *Nature.*, **145**: 150-151.

Duddington, C.L. (1951). The ecology of predacious fungi, I. Preliminary survey. *Trans. Br. Microbial. Soc*., **34**: 322–331.

Gray, N.F. (1987). Nematophagous fungi with particular reference to their ecology, *Biological Reviews*, **62**: 245-304.

Kerry, B.R., Hominick W.B. (2002). Biological Control. In: The biology of nematode. (ed. D.L. Lee). Taylor and Francis, London, New York, 483-510.

Kumar, D. (2024a). Effectiveness of various nematode-trapping fungi for biocontrol of the *Meloidogyne incognita* in tomato (*Lycopersicion esculentum* mill.). Rhizosphere, 29, 100845. https://doi.org/10.1016/j.rhisph.2023.100845.

Kumar, D. (2024b). Evaluation of nematophagous and biocontrol efficacy of *Dactylellina phymatopaga* against *Meloidogyne graminicola* on rice (*Oryza sativa* L.). *Biological Control*, **188**, 105425.

Kumar, D. and Gouda, S.A. (2018). Evaluation of mycoparasitic efficacy of nematode-trapping fungi against *Rhizoctonia solani* inciting sheath blight disease in rice (*Oryza sativa* L.). *Biol. Control*, **122**, 31–40.

Kumar, D. and Singh, K. P. and Jaiswal, R. K. (2005a). Effect of fertilizers and neem cake amendments in soil on spore germination of *Arthrobotrys dactyloides*. *Mycobiology,* **33**(4), 194-199.

Kumar, D., Singh, K.P., Jaiswal, R.K. (2005b). Screening of different media and substrates for cultural variability and mass culture of *Arthrobotrys dactyloides* Drechsler. *Mycobiology*, **33**, 215–222.

Kumar, D. (2017). Genomic insights into the adaptation to parasitism in nematode - trapping fungi and transcriptomics during infection of *Caenorhabditis briggsae* and plant-parasitic nematodes. *Indian Phytopathol*. **70**(1), 32-39.

Kumar, D. (2021). Evaluation of Nematophagous ability of *Dreshslrella dactyloides* in vicinity to soil and bio control potential against root knot disease of brinjal. *Indian J. Pure App. Biosci.,* **9**(1), 403-410.

Kumar, D., Maurya, N., Kumar, P., Singh, H., Addy, S.K. (2015). Assessment of germination and carnivorous activities of a nematode-trapping fungus *Arthrobotrys dactyloides* in fungistatic and fungicidal soil environment. *Biol. Control*, **82**, 76-85.

Kumar, D., Singh, K.P. (2006a). Variability in Indian isolates of *Arthrobotrys dactyloides* Drechsler: a nematode-trapping fungus. *Curr. Microbiol*. **20**, 1–8.

Kumar, D., Singh, K.P. (2006b). Assessment of predacity and effect of *Arthrobotrys dactyloides* for biological control of root-knot disease of tomato. *J. Phytopathol*. **154**, 1–5.

Kumar, N., Singh, R.K., Singh, K.P. (2010). Occurrence and colonization of nematophagous fungi in different substances, agricultural soils and root galls, *Archives of Phytopathology and Plant Protection*, **1**: 1-14.

Maupas, E. (1915). Sur un champignon parasite des *Rhabditis. Bull. Soc. Hist. Nat. Afriquedu. Nord*, **6**: 34-49.

Meerupati, T., Andersson, K. -M, Friman, E., Kumar, D., Tunlid, A. and Ahre´n, D. (2013). Genomic Mechanisms Accounting for the Adaptation to Parasitism in Nematode-Trapping Fungi. PLOS Genet. DOI: 10.1371/ *journal.pgen*.1003909

Mo, M.H., Chen, W.M., Yang, H.R., Zhang, K.Q. (2008). Diversity and metal tolerance of nematode trapping fungi in Pb-polluted soils, *Journal of microbiology* (Seoul, Korea), **46**, 166-22.

Persmark, L., Banck, A., Jansson, H.B. (1996). Population dynamics of nematophagous fungi and nematodes in an arable soil: vertical and seasonal fluctuations. *Soil Biology and Biochemistry*, **28**, 1005-1014.

Saxena, G. (2008). Observation on the occurrence of nematophagous fungi in Scotland. *Applied soil Ecology*, **39**, 352-357.

Shepherd, A.M. (1955). *Harposporium crassum*. Sp. nov. Trans. Br. *Mycol. Soc*., **38**: 47-48.

Singh, K.P., Jaiswal, R.K., Kumar, N. and Kumar, D. (2007). Nematophagous fungi associated with root galls of rice caused by *Meloidogyne graminicola* and its control by *Arthrobotrys dactyloides* and *Dactylaria brochopaga*. *J. Phytopathol.* **155**, 193-197.

Singh, K.P., Kumar, D., Bandyopadhyay, P. (2004). A new technique for single spore isolation of two predacious fungi forming constricting ring. *Mycobiology*, **32**, 197–198.

Singh, R.K., Pandey, S.K. and Chattopadhyay, A. (2014). Biodiversity and periodical/seasonal distribution of nematode-trapping fungi from different habitats. *J. Pure Appl. Microbiol*, **9**(1), 767-776.

Soprunov, F.F. (1958). Predacious hyphomycetes and their application in the control of plant pathogenic nematodes, Acad. Sci. Turkmen SSR. Ashabed (English Translation) 1966, *Israel Programme for Scientific Translation*, 1958.

Su, H., Hao, Y.E., Mo, M., Zhang, K. (2007). The Ecology of nematode trapping hyphomycetes in cattle dung from three plateau pastures, *Veterinary Parasitology*., **144**: 293-298.

Su, H., Zhao, Y., Zhou, J., Feng, H., Jiang, D., Zhang, K.Q., Yang, J. (2015). Trapping devices of nematode-trapping fungi: formation, evolution, and genomic perspectives. *Biol. Rev. Camb. Philos. Soc*. **31**, 371–378.