

Dominant genera of plant-parasitic nematodes in kepok banana (*Musa acuminata* × *balbisiana*) cultivation in Pidie, Indonesia

Genus dominan nematoda parasit tumbuhan pada budidaya pisang kepok (*Musa acuminata* × *balbisiana*) di Pidie, Indonesia

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ABSTRACT

Banana (*Musa spp.*) is a vital agricultural commodity in Indonesia. In Pidie Regency, Aceh, Indonesia, production declined significantly by 46% between 2021 and 2023, partly due to infestations by plant-parasitic nematodes. This study aimed to identify the dominant genera of parasitic nematodes in the kepok banana (*Musa acuminata* × *balbisiana*) cultivar grown in Padang Tiji District, Pidie, Indonesia, using soil samples collected from three villages. Four nematode genera were identified: *Pratylenchus*, *Helicotylenchus*, *Meloidogyne*, and *Xiphinema*. *Pratylenchus* was dominant in Tunong Tanjong and Keupula Tanjong fields, while *Helicotylenchus* predominated in Tuha Peudaya. The highest nematode abundance was recorded in the Tunong Tanjong field, averaging 33,973.4 individuals per 10 g of soil. These findings provide valuable baseline data for nematode pest management and support the development of targeted control strategies to enhance sustainable banana cultivation in the region.

ABSTRAK

Pisang (*Musa spp.*) merupakan komoditas pertanian yang sangat penting di Indonesia. Di Kabupaten Pidie, Aceh, Indonesia, produksi pisang mengalami penurunan signifikan sebesar 46% antara tahun 2021 hingga 2023, yang sebagian disebabkan oleh infestasi nematoda parasit tumbuhan. Penelitian ini bertujuan untuk mengidentifikasi genus dominan nematoda parasit pada kultivar pisang kepok (*Musa acuminata* × *balbisiana*) yang dibudidayakan di Kecamatan Padang Tiji, Kabupaten Pidie, Indonesia, melalui pengambilan sampel tanah dari tiga desa. Hasil identifikasi menunjukkan empat genus nematoda: *Pratylenchus*, *Helicotylenchus*, *Meloidogyne*, dan *Xiphinema*. Genus *Pratylenchus* mendominasi lahan Tunong Tanjong dan Keupula Tanjong, sedangkan *Helicotylenchus* mendominasi lahan Tuha Peudaya. Kelimpahan nematoda tertinggi tercatat di lahan Tunong Tanjong, dengan rata-rata 33.973,4 individu per 10 g tanah. Temuan ini memberikan data dasar yang berharga untuk pengelolaan hama nematoda dan mendukung pengembangan strategi pengendalian yang terarah guna meningkatkan keberlanjutan budidaya pisang di wilayah tersebut.

INTRODUCTION

Bananas (*Musa spp.*) are among the most important agricultural commodities and the most widely consumed fruits in Indonesia (Rai et al., 2018). One of the most commonly found banana cultivars in Indonesia is the kepok banana (*Musa acuminata* × *balbisiana*). Aceh Province is one of the banana-producing regions in Indonesia, with a production of 1,120,371 tons in 2023 (BPS, 2024). Padang Tiji District is a key banana-producing area in Pidie Regency, with approximately 419,670 banana plants, contributing approximately 71.24% of the total banana production in the regency (Dinas Pertanian

dan Pangan Kabupaten Pidie, 2020). However, recently, almost all banana varieties have been affected by diseases, hindering the development of this crop and causing significant losses for banana farmers in the region (Anggrayni et al., 2025; Bukhari & Safridar, 2018). One of the main causes of declining banana production is plant pests and diseases. Banana plant diseases are commonly caused by pathogens such as bacteria, viruses, fungi, and nematodes. In the kepok banana fields of Tunong Tanjong, Keupula Tanjong, and Tuha Peudaya villages in Pidie Regency, Indonesia, the plants exhibit symptoms such as wilting during the day, dull yellow leaves, slow growth, and signs of nutrient deficiency. It is suspected that the kepok banana plants in these three areas are infested with parasitic nematodes.

Parasitic nematodes are a significant cause of economic losses in banana cultivation (Nurlaili, 2025). According to Indriyati (2017), nematode infections in plants can disrupt growth and lead to a decrease in both the quality and quantity of harvests, with nematode attacks causing losses of up to 70% in banana plants. Research by Odala et al. (2020) indicated that in the rhizosphere and roots of banana plants in India, parasitic nematodes such as *Meloidogyne* sp., *Helicotylenchus* sp., *Pratylenchus* sp., and *Radopholus* sp. were present. In Indonesia, banana plants are also affected by parasitic nematodes, as evidenced by research conducted by Nasution et al. (2025), which found parasitic nematodes *Helicotylenchus* sp., *Meloidogyne* sp., and *Pratylenchus* sp. in soil and root samples of kepok and raja banana plants in Paloh Jeurela Village, Pidie Regency. The dominant parasitic nematodes found in root and soil samples of banana plants in Sleman and Bantul regencies in the Special Region of Yogyakarta were *Helicotylenchus multicinctus* and *Pratylenchus coffeae* (Nurlaili, 2025).

Although several previous studies have confirmed the presence of parasitic nematodes in banana plants, most have been limited to detection without identifying the dominant genera (Demesyeux et al., 2020; Luambano et al., 2019). This lack of specificity hampers the development of targeted strategies for nematode management. Moreover, the agroecological conditions and potential nematode species composition in Padang Tiji District, Pidie, Indonesia, may differ from those in other regions, making localized studies necessary. Therefore, identifying the dominant genus of parasitic nematodes in this area is crucial to support more accurate and effective control efforts. This study aims to identify the dominant genera of plant-parasitic nematodes associated with kepok banana (*Musa acuminata* × *balbisiana*) cultivation in Padang Tiji District, Pidie, Indonesia. The results are expected to provide valuable data for localized nematode management and sustainable banana production.

MATERIALS & METHODS

Soil sampling from banana plants

Soil samples from banana plants were collected from banana plantations in Tunong Tanjong, Keupula Tanjong, and Tuha Peudaya Village in Padang Tiji District, Pidie Regency, Indonesia. Sampling was conducted using the diagnostic method, which involves collecting samples from banana plants showing symptoms of nematode infestation. Soil samples were taken at a depth of 10–20 cm in the plant rhizosphere. From each field, soil samples were collected from 10 symptomatic banana plants, approximately 100 g of soil taken per plant. Each collected soil sample was placed in a Ziplock plastic bag and labeled with the sample number, village name, plantation number, and date of collection (Pusat Karantina Tumbuhan, 2010). The samples were then transported to the Plant Disease Science Laboratory, Faculty of Agriculture, Syiah Kuala University, Indonesia, for extraction and identification.

Nematode extraction

Nematode extraction was conducted using the Baermann funnel method. This technique involves a funnel connected to a rubber tube, with the lower end of the tube secured with a clamp to prevent water from leaking. A 10 g soil sample was wrapped in a filter cloth and placed inside the funnel, which was then supported by a stand and filled with 70 mL of distilled water. After 24 h, the water at the bottom of the rubber tube was released into a test tube for further analysis. Each soil sample was extracted using a separate Baermann funnel (Bezooijen, 2006)

Morphological identification of parasitic nematodes

Morphological identification of parasitic nematodes was conducted under a binocular microscope with 10×10 and 40×10 magnifications. A glass slide was prepared with a drop of water containing the extracted nematodes. Observations focused on key morphological characteristics, particularly the mouthparts (presence or absence of a stylet), stylet shape, esophagus, reproductive organs, and tail shape (Pusat Karantina Tumbuhan, 2010).

Abundance of parasitic nematodes

Abundance refers to the number represented by each genus of all individuals within the community. Parasitic nematodes were separated according to their respective genera after identification. The total number of individuals from each nematode genus in the sampled observation fields in Tunong Tanjong, Keupula Tanjong, and Tuha Peudaya villages in Padang Tiji District, Pidie, Indonesia, was counted in the Plant Pathology Laboratory, Faculty of Agriculture, Syiah Kuala University, Indonesia.

RESULTS & DISCUSSION

Identification of morphological parasitic nematodes

Based on the observations, each genus of parasitic nematodes in plants exhibits diverse morphological characteristics. Several aspects can be observed to differentiate nematode genera, including the shape and length of the stylet, body shape, body size, tail characteristics, and life cycle. The identification results revealed four genera of parasitic nematodes: *Pratylenchus*, *Helicotylenchus*, *Meloidogyne*, and *Xiphinema*. These four genera were found in soil samples from kepok banana fields in Tunong Tanjong, Keupula Tanjong, and Tuha Peudaya villages in Padang Tiji District, Pidie Regency. The morphological characteristics of the identified genera are described below.

Pratylenchus

The body of *Pratylenchus* is slender and elongated, with a large, rounded head region, flat lips without protrusions or complex shapes around the mouth, and a short stylet equipped with a thicker and stronger basal knob. It has a long tail. This is consistent with the statement by (Luambano et al., 2019), which indicates that *Pratylenchus* nematodes have a short and strong stylet measuring 14-20 μm in length with a thick basal knob. Female *Pratylenchus* nematodes have a visible vulva located along the body length. The observed morphological characteristics were similar to those reported by (Dede et al., 2014), where female *Pratylenchus* nematodes have a prominent vulva (Figure 1).



Figure 1. Morphological of female nematode of *Pratylenchus*; (a) Whole body appearance (magnification 10x10); (b) Anterior part (magnification 40x10); (c) Posterior part (magnification 40x10)

Helicotylenchus

Helicotylenchus is also known as spiral nematodes due to its spiral shape, although it can sometimes appear in a C-shape. The *Helicotylenchus* specimens observed exhibit spiral morphological characteristics in the resting phase, with a blunt

conical head. The stylet is long, the lips are not notched or set off, and the knob is round or bowl-shaped. The tail is short, and generally, the dorsal part resembles a cone with a protrusion at the tip of the male nematode's tail, which envelops the tail's end. The morphology of *Helicotylenchus* can be seen in Figure 2.

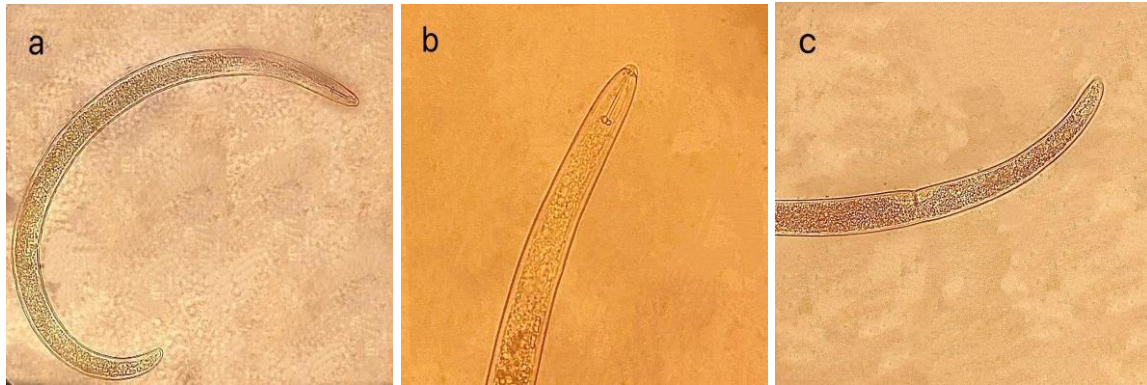


Figure 2. Morphological of female nematode of *Helicotylenchus*; (a) Whole body appearance (magnification 10x10); (b) Anterior part (magnification 40x10); (c) Posterior part (magnification 40x10)

Meloidogyne

Meloidogyne nematodes have a relatively straight body shape, with lips that are not set off or lacking a lip curvature, and they possess a long stylet and tail. Female and male *Meloidogyne* nematodes exhibit different body shapes. A distinctive feature of female nematodes is their pear or avocado-like body shape, with a posterior that appears swollen. In contrast, the male nematodes observed have a cylindrical shape and move slowly, with a narrower posterior and a tail that tapers to a point. The morphological characteristics obtained are similar to those reported by (Dropkin, 1989), which state that adult male *Meloidogyne* nematodes have a cylindrical shape and move slowly in the soil, with a maximum length of 2 μm . Their heads are not notched, and the length of their stylet is nearly twice that of the female stylet. However, in this study, the *Meloidogyne* nematodes observed were still in the juvenile stage, and therefore, their sex could not be identified. The morphology of the *Meloidogyne* genus can be seen in Figure 3.

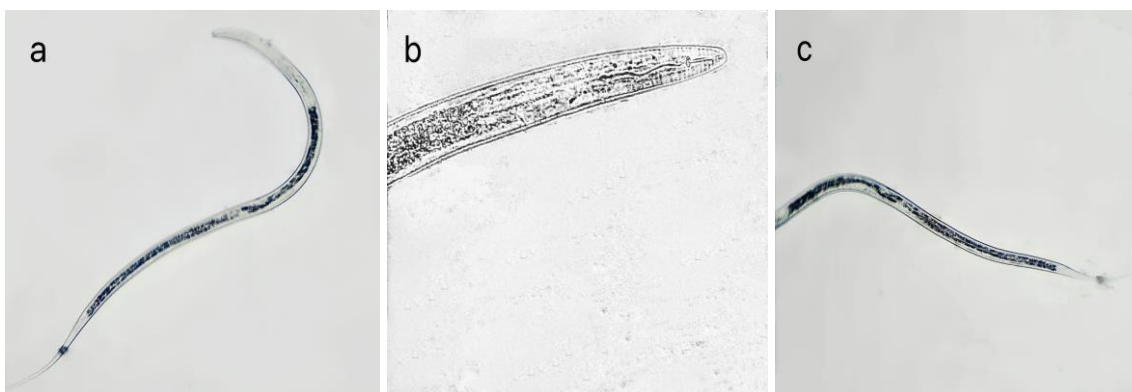


Figure 3. Morphological nematode of *Meloidogyne*; (a) Whole body appearance (magnification 10x10); (b) Anterior part (magnification 40x10); (c) Posterior part (magnification 40x10)

Xiphinema

Nematodes from the genus *Xiphinema* have several distinctive features that differentiate them from other nematodes, particularly their stylet shape. *Xiphinema* possesses a very long stylet resembling a needle. The dorsal part is convex, with a spicule area, and the tip of the tail has a small protrusion (Figure 4). The morphology of *Xiphinema* sp. includes a slightly convex lip region measuring about 3-4 μm . There are two nerve rings located at the posterior base of the odontophore (stylet support) with a width of 11-13 μm , and the tail tip is conical, with a straight and slender body shape (Chizhov et al., 2014).



Figure 4. Morphological nematode of *Xiphinema*; (a) Whole body appearance (magnification 10x10); (b) Anterior part (magnification 40x10); (c) Posterior part (magnification 40x10)

Abundance of parasitic nematodes

Based on the observations of parasitic nematodes in the fields of Tunong Tanjung, Keupula Tanjung, and Tuha Peudaya villages, four genera of parasitic nematodes were found with varying abundance. The percentage data of parasitic nematode abundance in the kepok banana plants in Tunong Tanjung Village can be seen in Table 1.

Table 1. Percentage of plant-parasitic nematode genera in kepok banana cultivation in Tunong Tanjung Village

No.	Genera of parasitic nematodes	Total nematode parasitic (individual/10 g soil)	NP (%)
1.	<i>Pratylenchus</i>	17,476.7	52
2.	<i>Helicotylenchus</i>	8,096.7	24
3.	<i>Meloidogyne</i>	5,576.7	16
4.	<i>Xiphinema</i>	2,823.3	8
Total		33,973.4	

Note. NP = Nematode percentage (number of individuals of each genus divided by the total number of nematodes)

The abundance of parasitic nematodes in the Tunong Tanjung fields was an average total of 33,973.4 individuals per 10 g of soil (see Table 1). The dominant parasitic nematode found belongs to the genus *Pratylenchus*, with an average total of 17,476.7 individuals per 10 g of soil, accounting for 52% of the total. The lowest number of parasitic nematodes was from the genus *Xiphinema*, with an average of 2,823.3 individuals per 10 g of soil, representing 8%.

Table 2. Percentage of plant-parasitic nematode genera in kepok banana cultivation in Keupula Tanjung Village

No.	Genera of parasitic nematodes	Total nematode parasitic (individual/10 g soil)	NP (%)
1.	<i>Pratylenchus</i>	7,980	40
2.	<i>Helicotylenchus</i>	5,040	26
3.	<i>Meloidogyne</i>	2,636.7	13
4.	<i>Xiphinema</i>	4,223.3	21
Total		19,880	

Note. NP = Nematode percentage (number of individuals of each genus divided by the total number of nematodes)

In the Keupula Tanjung fields, the abundance of parasitic nematodes was found to be an average total of 19,880 individuals per 10 g of soil (Table 2). The dominant parasitic nematode identified belongs to the genus *Pratylenchus*, with an average

total of 7,980 individuals per 10 g of soil, accounting for 40% of the total. The lowest number of parasitic nematodes in this area was from the genus *Meloidogyne*, with an average of 2,636.7 individuals per 10 g of soil, representing 13%

Table 3. Percentage of plant-parasitic nematode genera in kepok banana cultivation in Tuha Peudaya Village

No.	Genera of parasitic nematodes	Total nematode parasitic (individual/10 g soil)	NP (%)
1.	<i>Pratylenchus</i>	6,300	36
2.	<i>Helicotylenchus</i>	8,120	47
3.	<i>Meloidogyne</i>	2,543.3	16
4.	<i>Xiphinema</i>	466.7	3
Total		17,430	

Note. NP = Nematode percentage (number of individuals of each genus divided by the total number of nematodes)

The abundance of parasitic nematodes in the Tuha Peudaya fields was found to be an average total of 17,430 individuals per 10 g of soil, as shown in Table 3. The dominant parasitic nematode in the Tuha Peudaya area was from the genus *Helicotylenchus*, with an average total of 8,120 individuals per 10 g of soil, accounting for 47% of the total. The lowest number of parasitic nematodes in this area was from the genus *Xiphinema*, with an average of only 466.7 individuals per 10 g of soil, representing 3%.

Based on the results of the percentage abundance of parasitic nematodes obtained from the fields in Tunong Tanjong, Keupula Tanjong, and Tuha Peudaya villages, it is known that the highest abundance was found in the Tunong Tanjong fields. This may be attributed to the land conditions in Tunong Tanjong, which has a larger area as it is adjacent to other residents' banana fields, and there are weeds in the surrounding area. Such environmental conditions may enhance nematode population growth by increasing host plant availability and providing favorable microhabitats. This is supported by Hasanah et al. (2014), who stated that weeds can serve as alternative hosts and food sources for parasitic nematodes. (Winarto, 2015) noted that several factors influence the life cycle of nematodes; if food availability is abundant and environmental conditions are supportive, parasitic nematodes can reproduce well, resulting in an increased nematode population.

In contrast, the lowest abundance of parasitic nematodes was found in the Tuha Peudaya fields. This is suspected to be due to the land conditions being less extensive, as it is located near residential areas. Therefore, the abundance of parasitic nematodes in this area is lower. The reasons for the high and low abundance of parasitic nematodes in each field are thought to be due to the varying factors that support the development of parasitic nematodes in each area. Among the four genera of parasitic nematodes found in these three villages, the dominant genera were *Pratylenchus* and *Helicotylenchus*. This is because both of these parasitic nematodes have the same primary host, which is the banana plant. According to (Ali, 2017), root-knot nematodes (*Pratylenchus* spp.) are the main parasitic nematodes affecting banana plants, and *Helicotylenchus multicinctus* is the primary nematode frequently found in banana plants (Gowen et al., 2005).

The high populations of these two nematodes are also due to the samples being identified from soil samples around banana roots. It is known that the life cycle of *Pratylenchus* nematodes involves living as migratory endoparasites within root tissues and can also exist in the soil. This is consistent with the statement by (Handoo et al., 2021), which indicates that *Pratylenchus* sp. nematodes are endoparasitic nematodes that migrate. Meanwhile, *Helicotylenchus* nematodes have a life cycle that occurs in the soil, as they are classified as ectoparasitic nematodes. This is supported by (Chen et al., 2024), which states that the life cycle of *Helicotylenchus* sp. nematodes occurs outside of plant tissues, commonly referred to as ectoparasitic nematodes.

Meloidogyne nematodes have banana plants as their primary host; however, these nematodes have a life cycle within the roots, with very few existing outside of root tissues. According to (Sarmah, 2022), *Meloidogyne* nematodes are classified as sedentary endoparasites, meaning that once they infect a host plant, they will remain within the plant's tissues, resulting in a low population in the soil. On the other hand, *Xiphinema* nematodes are ectoparasitic but have the lowest abundance because banana plants are not their primary hosts. According to (Demangeat et al., 2005), *Xiphinema* nematodes can survive in soil at extreme temperatures of 11°C, but they cannot withstand temperatures of 45°C. The optimal temperature for *Xiphinema* nematodes to reproduce is 24°C. According to (Cahyono, 2002) banana plants are tropical plants that thrive at optimal temperatures of 27°C - 38°C. Based on this information, it can be understood why *Xiphinema* nematodes have the lowest population in banana plants, as they cannot reproduce effectively due to unsuitable environmental temperatures.

CONCLUSIONS

The study revealed that the highest abundance of plant-parasitic nematodes occurred in Tunong Tanjung Village. *Pratylenchus* was the dominant genus in both Tunong Tanjung and Keupula Tanjung, whereas *Helicotylenchus* predominated in Tuha Peudaya. These findings provide valuable baseline data for the development of site-specific nematode management strategies to support sustainable kepok banana cultivation in Pidie, Indonesia. Further studies are needed to explore seasonal dynamics, host–nematode interactions, and integrated control approaches under diverse agroecological conditions.

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