



## Varietal Influence on the Abundance and Community Structure of Plant-Parasitic Nematodes in Potato Fields of Solok Regency, Indonesia

Duma Putri Tama\*, Trizelia<sup>2</sup>, Yenny Liswarni<sup>3</sup>, Hal Adi Fikri Ananda<sup>4</sup>, Annisa Hidayatullah<sup>5</sup>

<sup>1,2,3,4,5</sup>Departemen Proteksi Tanaman, Universitas Andalas, Padang, Indonesia

\*Corresponding Author: [duma.putri@gmail.com](mailto:duma.putri@gmail.com)<sup>1</sup>, [trizelia@agr.unand.ac.id](mailto:trizelia@agr.unand.ac.id)<sup>2</sup>, [yennyliswarni@agr.unand.ac.id](mailto:yennyliswarni@agr.unand.ac.id)<sup>3</sup>

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### Abstrak

Kentang (*Solanum tuberosum* L.) merupakan komoditas hortikultura strategis di Indonesia, namun produktivitasnya sering terkendala oleh serangan nematoda parasit tanaman. Penelitian ini bertujuan untuk mengetahui pengaruh varietas kentang terhadap kelimpahan dan struktur komunitas nematoda parasit tanaman di sentra produksi kentang Kabupaten Solok. Pengambilan sampel tanah dilakukan secara acak menggunakan metode zig-zag pada lahan kentang varietas merah dan putih di beberapa lokasi dengan perbedaan ketinggian tempat. Ekstraksi nematoda dilakukan menggunakan metode corong Baermann, diikuti dengan perhitungan populasi, identifikasi genus, serta analisis frekuensi kehadiran. Hasil penelitian menunjukkan bahwa komunitas nematoda parasit didominasi oleh genus *Meloidogyne* pada kedua varietas, dengan populasi dan frekuensi kehadiran yang lebih tinggi pada varietas kentang merah. Varietas kentang putih menunjukkan total populasi nematoda yang lebih rendah dengan struktur komunitas yang lebih beragam. Perbedaan ini mengindikasikan adanya pengaruh varietas terhadap perkembangan populasi nematoda parasit tanaman. Temuan ini menegaskan pentingnya pemilihan varietas sebagai bagian dari strategi pengelolaan nematoda terpadu pada budidaya kentang di Kabupaten Solok.

### Abstract

Potatoes (*Solanum tuberosum* L.) are a strategic horticultural commodity in Indonesia, but their productivity is often hampered by attacks from plant-parasitic nematodes. This study aims to determine the effect of potato varieties on the abundance and structure of plant-parasitic nematode communities in the potato production centre of Solok Regency. Soil samples were collected randomly using the zig-zag method from red and white potato fields at several locations with different elevations. Nematodes were extracted using the Baermann funnel method, followed by population calculation, genus identification, and frequency of occurrence analysis. The results showed that the parasitic nematode community was dominated by the genus *Meloidogyne* in both varieties, with higher populations and frequency of occurrence in red potato varieties. White potato varieties showed lower total nematode populations with more diverse community structures. These differences indicate the influence of variety on the development of plant parasitic nematode populations. These findings emphasise the importance of variety selection as part of an integrated nematode management strategy in potato cultivation in Solok Regency.

## PENDAHULUAN

Potatoes (*Solanum tuberosum* L.) are one of the food crops grown in Indonesia, after wheat, rice and corn. Potatoes also have nutritional value, which is why they are widely

cultivated in various regions of Indonesia. In Indonesia, potatoes play an important role as a commodity for home-based businesses, as a vegetable, and are often used in processed foods and large-scale industries for the production of flour and crisps. Potatoes have great potential as a source of carbohydrates for human consumption (Mulyono et al. 2017). From a regional economic perspective, potatoes are a source of livelihood for some communities due to their high economic value. Potatoes are also one of the commodities that contribute to inflation due to their fluctuating prices. Therefore, potatoes are an important and strategic commodity. Potatoes are worth cultivating and developing because of their high economic value and increasing demand as their use for various purposes, both as food and in industry, continues to expand (Aprianto et al. 2023). Potato cultivation and production in Indonesia have grown rapidly, making Indonesia one of the largest potato-producing countries in Southeast Asia (Ummah and Purwito, 2009).

In potato cultivation, one of the obstacles to increasing production is nematode infestation. Nematodes have become a serious problem in potato production centres in Indonesia, as they can drastically reduce production in terms of both quality and quantity (Jaiswal et al. 2011). Attacks from parasitic nematodes can cause yield losses of 10% to 80% (Directorate General of Horticulture, 2016). Potato plants infected with nematodes exhibit abnormal growth, withering, stunting and a tendency to wilt in relatively dry soil or air humidity, whereas uninfected plants remain fresh. When the roots are dug up, swelling and lumps will be visible on the roots. Meanwhile, infected potato tubers will have lumps, change shape, and show other symptoms of infection in the flesh under the skin of the tuber. Severe attacks can disrupt tuber formation and cause the tubers to become deformed, resulting in reduced production in terms of both quality and quantity (Hendry, 2024).

More than 68 species belonging to 24 genera have been reported to be associated with potato cultivation worldwide (Hafez dan Portener, 2011). The type and population density of nematodes are influenced by several factors such as temperature, humidity, host plants, pesticide use (Mulyadi, 2009), and the length of time the land has been used for cultivation (Winarto et al, 2019). Information on the diversity of nematode species associated with potato cultivation has been reported by several researchers (Dong et al. 2017). In the rhizosphere of potato plants in Kerinci District, Jambi Province, four types of nematodes were found, namely *Meloidogyne*, *Pratylenchus*, *Helicotylenchus*, and *Xiphinema* (Hamidi, 2017), while in Bandung District, West Java Province, four types of nematode genera were found, namely *Meloidogyne*, *Pratylenchus*, *Helicotylenchus*, and *Globodera* (Simamora, 2007). Parasitic nematodes on potato plants found by (Luc et al. 2007), include *Globodera*, *Meloidogyne*, *Nacobus aberrans*, *Ditylenchus*, *Pratylenchus*, *Radophulus similis*, and *Trichodorus*.

Solok Regency, located at an altitude of 700-1500 metres above sea level with an average temperature ranging from 12-25°C, is one of the potato growing centres in West Sumatra, so the presence of plant parasitic nematodes as one of the important plant pests needs to be taken seriously. Differences in altitude are thought to affect the abundance and diversity of potato parasitic nematodes. In addition, farmers in Solok Regency grow two types of potatoes: yellow potatoes (Granola variety) and red potatoes (Desiree variety). Differences in plant varieties also affect the development of nematode populations. Research through the exploration of nematode species that attack potato plants based on potato type and altitude can be used as a basis for developing prevention and control strategies. Pathogenic nematodes, as one of the factors limiting potato production, need to be considered so as not to cause disease outbreaks. Efforts to prevent disease outbreaks can begin with the identification of pathogens around the plants.

## METODE

### Soil sampling

Soil samples were taken in three subdistricts, namely X Koto and Sungai Tarab. Samples were taken randomly using the zig-zag method with three replicates, each taken from a different point. The land used for soil sampling was mono- and poly-cultured potato fields. Soil sampling was carried out at two points around the plant stem, 15 cm from the base of the stem. Soil samples were taken at a depth of 30 cm using a 5.5 cm diameter soil drill, yielding a soil volume of 712.38 cm<sup>3</sup>. This result was obtained from the volume formula  $\pi r^2 t$ . Each soil sample was then placed in a labelled plastic bag and taken to the laboratory.

### Extraction of nematodes from soil samples

Nematode extraction from soil can be done using the Baermann funnel method, which is as follows A set of Baermann funnels is prepared, the clamp on the hose is tightened, then filled with water until the water surface touches the soil retaining mesh inside the funnel. Approximately 300 grams of soil sample is placed on top of the wire mesh lined with tissue paper. The water surface inside the funnel must cover all soil samples on the tissue paper for 2x24 hours. Water is added through the edge of the funnel surface, taking care not to touch the soil. After 2 days, nematodes are observed by taking 20 ml of water from the hose that has been extracted by opening the hose clamp and collecting it in a Petri dish, then observing the nematodes with a stereo binocular microscope.

### Nematode Population Calculation

The nematode population was calculated by pouring the extraction suspension into a Siracusa dish and then observed under a stereo and compound microscope with 10 x 10 magnification.

### Identification of parasitic nematodes

The nematodes obtained in the Petri dish were then killed by heating them over a Bunsen burner. Each dead specimen was taken to make a preparation. The preparation was made by taking each dead specimen using a dropper, transferring it to a glass slide, covering it with a cover slip, and observing it using a microscope. To determine the genus of the nematodes obtained, they were identified based on their dead form, anterior, presence of a stylet, and posterior. Observations were made using a binocular microscope. The observation results were matched using identification books.

### Soil moisture content measurement

Soil moisture content was measured using the gravimetric method. Ten grams of soil (wet weight) was weighed and placed in an aluminium dish, then dried in an oven at 105°C for 24 hours or until the weight was constant. The oven-dried soil was weighed again to determine its dry weight. Soil moisture content was calculated using the formula.

### Data Analysis

The parasitic nematode population density is calculated by grouping nematodes by genus based on the identification results. Next, the nematode population density (K) is calculated.

## HASIL DAN PEMBAHASAN

### Soil sampling

Soil sampling was carried out on potato (*Solanum tuberosum*) cultivation land in several production centres in Solok Regency, representing different types of land and altitudes. Sampling locations were selected purposively based on the intensity of potato cultivation and

variations in altitude, aiming to represent the diverse agroecosystem conditions of potatoes. Soil samples were taken from the root zone of potato plants at a specific depth that is commonly inhabited by plant parasitic nematodes.



**Figure 1.** Potato cultivation land where soil samples were collected

Field observations showed differences in soil physical conditions, such as soil texture, moisture, and cultivation management systems, between sampling locations. These variations affected the presence, abundance, and diversity of plant-parasitic nematodes. The collected soil samples were then labelled according to location and altitude and stored under appropriate conditions to maintain nematode viability prior to extraction and identification in the laboratory. The data from these samples form an important basis for analysing the abundance and diversity of plant-parasitic nematodes in potato cultivation in Solok Regency.

## Nematode Population Calculation

### 1. Parasitic nematode population density (individuals/cm<sup>3</sup>)

The results showed that the plant parasitic nematode community in potato cultivation in the production centre of Solok Regency was dominated by several main genera with different abundance levels between red and white potato varieties. Table 1. shows data on the abundance and composition of plant-parasitic nematode genera found in red potato and white potato crops.

**Table 1.** The abundance and composition of plant-parasitic nematode genera found in red potato and white potato crops.

Genus	Varietas	
	red potato (individual)	white potato (individual)
<i>Meloidogyne</i>	164	27
<i>Pratylenchus</i>	78	-
<i>Tricodorus</i>	57	-
<i>Ditylenchus</i>	30	-
<i>Helicotylenchus</i>	24	11
<i>Rotylenchulus</i>	16	10
<i>Paratylenchus</i>	13	7
<i>Xiphinema</i>	1	-
<i>Anguina</i>	-	3
<i>Xiphinema</i>	-	1
<i>Scutellonema</i>	-	1

-: tidak ditemukan

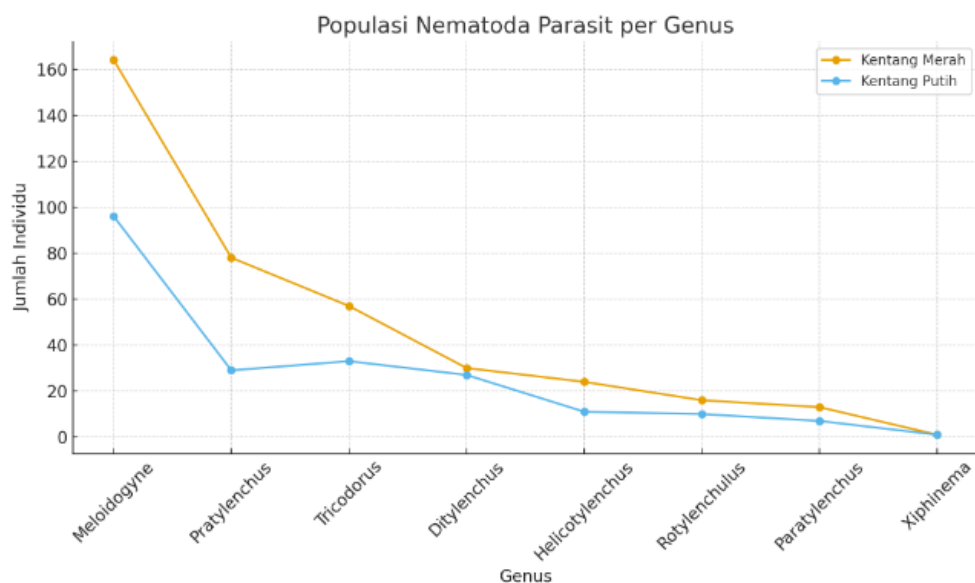


Figure 2. Graph of Parasitic Nematode Population per Genus

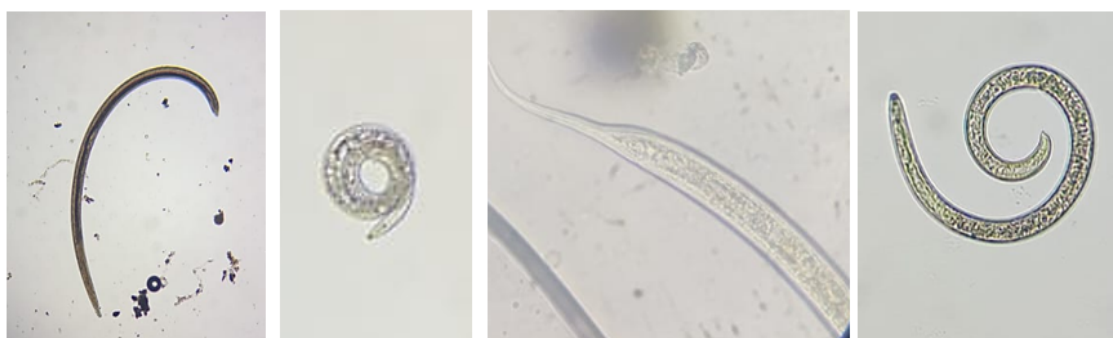


Figure 3. Dead nematode specimens found

The results showed that the plant parasitic nematode community in potato cultivation in the production centre of Solok Regency was dominated by several main genera with different abundance levels between red and white potato varieties. In red potatoes, a total of 363 parasitic nematodes were found, with the genus *Meloidogyne* being the most dominant nematode (164 individuals), followed by *Pratylenchus* and *Trichodorus*. The dominance of *Meloidogyne* indicates the potential for high biotic pressure because this genus is known as a root-knot nematode that is very harmful to potato plants and has a wide adaptability to various environmental conditions. The presence of other genera such as *Helicotylenchus*, *Rotylenchulus*, and *Paratylenchus* indicates the complexity of the parasitic nematode community in the rhizosphere soil of red potatoes.

In white potatoes, the total number of parasitic nematodes identified was lower, at 218 individuals, with a relatively smaller genus composition compared to red potatoes. The genus *Ditylenchus* was the most commonly found, followed by *Helicotylenchus* and *Rotylenchulus*, while *Meloidogyne* did not show the same level of dominance as in red potatoes. The differences in abundance and composition of parasitic nematodes between these two varieties indicate the influence of plant variety on host preference and nematode population development. This is in line with the view that plant varieties can influence nematode community structure through differences in root exudates, genetic resistance, and soil microhabitat conditions (Mai & Abawi, 1987; Perry & Moens, 2013).

The abundance of parasitic nematodes in red potatoes compared to white potatoes shows that red potato varieties tend to be more susceptible to parasitic plant nematode

attacks. The dominance of *Meloidogyne* in red potatoes also reinforces previous reports that root-knot nematodes are one of the main pathogens in potato cultivation systems in highland areas (Sasser & Freckman, 1987; Sikora et al., 2018). These findings emphasise the importance of integrated nematode management, including variety selection, crop rotation, and soil management, to suppress the population of parasitic nematodes in potato cultivation in Solok Regency.

Red potato varieties, such as Granola and Erika, are reported to be more susceptible to parasitic nematode attacks, particularly the yellow cyst nematode *Globodera rostochiensis*, compared to white potato varieties, which is related to differences in genetic and biochemical resistance mechanisms in the root system (Evans & Stone, 1977; Turner & Evans, 1998). In susceptible varieties, the plant's defence response to nematode infection tends to be weak, characterised by instability in the production of phenolic compounds such as chlorogenic acid, which acts as a precursor to lignin (Bergelson et al., 2001; Hofmann et al., 2010). This inconsistent production of chlorogenic acid causes the lignification process of the root cell walls to be suboptimal, making the tissue structure susceptible to degradation by nematode enzyme secretion (Veech, 1980; Bar-Or et al., 2005). This condition allows nematodes to form functional feeding sites in the form of syncytia, which play an important role in providing nutrients for the development and reproduction of *G. rostochiensis* (Gheysen & Mitchum, 2011; Sobczak & Golinowski, 2011). In contrast, white potato varieties or resistant varieties such as Hertha and Manohara show relatively stable chlorogenic acid accumulation at 4–6 weeks post-inoculation, which induces intensive lignification as a structural defence response of the plant (Kovács et al., 2015; Williamson & Kumar, 2006).

Screening results for resistance to *Globodera rostochiensis* in 20 potato varieties cultivated in Indonesia showed that the Granola (red, susceptible) and Erika varieties had significantly higher nematode populations than other varieties (Suharto et al., 2019; Winarto et al., 2021). In contrast, the Hertha (white, resistant) and Manohara varieties were classified as moderate to resistant, as indicated by lower nematode reproduction rates and relatively normal root system development (Moens et al., 2018). These differences in resistance levels are reinforced by histopathological analysis using Safranin staining, which shows more intense and localised lignification of root cell walls in resistant varieties compared to susceptible varieties (Dropkin, 1989; Hussey & Grundler, 1998). These findings are in line with the concept of resistance based on the inhibition of feeding site formation and function as a key factor in suppressing the success of cyst nematode parasitism (Goverse & Smant, 2014). Therefore, integrated control studies consistently recommend the use of resistant varieties such as Hertha in cyst nematode endemic areas, given that planting susceptible varieties can cause yield losses of up to 70% (Turner & Subbotin, 2013; Jones et al., 2017).

## 2. Frequency of parasitic nematode presence

The results showed that the structure of the plant parasitic nematode community in potato cultivation in Solok Regency was dominated by the genus *Meloidogyne* in both potato varieties observed. This genus was found in all soil samples (100% frequency of occurrence) in both red and white potatoes, with the highest population recorded in red potatoes. The high frequency and abundance of *Meloidogyne* indicates that root-knot nematodes are the main pathogens that play a major role in the potato cultivation system in the study area. This is in line with reports that *Meloidogyne* has high adaptability, a wide host range, and is able to thrive in highland potato agroecosystems (Sasser & Freckman, 1987; Perry & Moens, 2013).

**Tabel 2.** Frequency of parasitic nematode presence

Genus	Frekuensi Kehadiran dari 10 sampel (%)	
	red potato	white potato
<i>Meloidogyne</i>	100	100
<i>Pratylenchus</i>	100	-
<i>Tricodorus</i>	100	100
<i>Ditylenchus</i>	100	-
<i>Helicotylenchus</i>	90	70
<i>Rotylenchulus</i>	70	80
<i>Paratylenchus</i>	50	30
<i>Xiphinema</i>	10	-
<i>Anguina</i>	-	30
<i>Xiphinema</i>	-	20
<i>Scutellonema</i>	-	10

In red potatoes, most parasitic nematode genera such as *Pratylenchus*, *Trichodorus*, and *Ditylenchus* also showed a very high frequency of occurrence (100%), while other genera such as *Helicotylenchus*, *Rotylenchulus*, and *Paratylenchus* were found with medium to low frequencies. The high frequency of occurrence and population of several key genera indicates that red potatoes provide host and rhizosphere conditions that are more conducive to the development of parasitic nematodes. These conditions indicate a higher level of susceptibility of red potatoes to soil-borne pathogens, particularly parasitic nematodes (Mai & Abawi, 1987).

In contrast, in white potatoes, although *Meloidogyne* was still found in all samples, the frequency of occurrence of several other genera was relatively lower than in red potatoes. The genera *Pratylenchus*, *Helicotylenchus*, and *Rotylenchulus* appeared with medium frequency, while genera such as *Paratylenchus*, *Anguina*, *Xiphinema*, and *Scutellonema* were only found in a small proportion of samples. This pattern indicates that white potatoes tend to have a relatively better resistance to parasitic nematodes, characterised by a lower total population despite a more diverse genus composition. This phenomenon is thought to be related to differences in variety responses to nematode infection, including physiological resistance mechanisms and differences in root exudates (Sikora et al., 2018).

The high frequency and population of *Meloidogyne* and *Pratylenchus* in both varieties, especially red potatoes, indicate high pathogenic pressure on potato cultivation land in Solok District. These two genera are known to be the main causes of root system disorders that can lead to root swelling, plant wilting, and a decline in potato tuber quality and yield. Therefore, the results of this study emphasise the importance of implementing integrated nematode management strategies, including the use of more tolerant varieties, non-host crop rotation, and sustainable soil management to suppress the population of parasitic nematodes in potato production centres.

## KESIMPULAN

Based on the results of the study, it can be concluded that the plant parasitic nematode community in potato crops in Solok Regency is dominated by the genus *Meloidogyne*, which was found with a 100% frequency of occurrence in both red and white potato varieties. The red potato variety showed a higher population and frequency of parasitic nematodes than the white potato variety, indicating a greater susceptibility to nematode attack. Conversely, the white potato variety had a lower total nematode population despite a relatively more diverse genus composition, suggesting a better tolerance or resistance to parasitic nematodes. These differences in nematode abundance and community structure indicate that plant varieties have

a significant effect on nematode population development in the soil. Therefore, the results of this study can be used as a basis for developing integrated nematode management strategies, particularly through the selection of more tolerant varieties to support sustainable potato production in Solok Regency.

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