Density analysis of plant-parasitic nematodes associated with corn crop in South Sulawesi

Hishar Mirsam, Amran Muis, Nurnina Nonci, Muhammad Azrai
Indonesian Cereals Research Institute, Jl. Dr. Ratulangi 274, Maros South Sulawesi

Email: hisharmirsam@yahoo.co.id

All authors are the main contributors to this paper

Abstract. Plant damage by parasitic nematodes is less recognized by farmers and people working in agriculture because the symptoms of parasitic nematodes are generally non-specific, run very slowly, and often mix with symptoms by other pathogens. This study aims to determine the population density of plant parasitic nematodes associated with several corn plantations in South Sulawesi. Sampling was carried out at several centers of corn plantations in South Sulawesi, namely Malakaji (Gowa), Bajeng (Gowa), Bontobili, Maros, and Soppeng. Nematode extraction was done by the simple modified Baerman method. The density of the plant parasitic nematode (PPN) community calculated was absolute community density, relative community density, absolute frequency, relative frequency, frequency of all nematodes, and dominance values. The highest PPN density was found in the Bontobili area with a dominance value of 47.60%. There were 8 genera of PPN that infested corn and spread to several corn plantations in South Sulawesi, namely Helicotylenchus, Pratylenchus, Longidorus, Xiphinema, Haplolaimus, Aphelenchus, Tylenchus, and Meloidogyne. The results of this study can be used as a basis for monitoring pathogenic attacks on corn by farmers and other researchers

1. Introduction
Corn is the second important food commodity after rice which has the highest priority in increasing food security in Indonesia. In South Sulawesi, corn is one of the crops cultivated by many farmers, with an average harvest area of 295,115 ha and production of 1,528,414 tons [1]. Efforts to develop corn in South Sulawesi still have several problems including biotic and abiotic factors. The abiotic factor which is climate change, while the biotic factor is the incidence of pests and diseases. One of the pathogens that is less aware of its existence is plant parasitic nematodes (PPN).

Plant parasitic nematodes are one of the pathogens that can cause harm in plant cultivation in the world. These parasitic nematodes have been found in food crop areas in the tropics. In Indonesia, PPN have long been reported to be associated with corn plant in Java and Sumatra [2]. Plant damage due to PPN is not well recognized by farmers and people working in agriculture. This is because the symptoms caused by PPN are generally non-specific, run very slowly, and often mix with symptoms by other pathogens. In fact, nematodes incidence can cause a significant reduction in yield. In general, the incidence of nematodes causes damage to the roots, because nematodes suck on root cells, so that the tissue vessels are disrupted, resulting in water and nutrient translocation is inhibited [3].

The presence and population density of nematodes is one of the keys in reducing the risk of incidence by other pathogens in corn plants because PPN is very possible to associate with other soil-
borne pathogens. Dropkin reported that infection with Pratylenchus and Radopholus nematodes could provide an opportunity for Fusarium fungus to exacerbate infections that eventually led to fusarium wilt in some agricultural commodities [4]. Therefore, the presence, distribution and density of PPN associated with corn plantations in South Sulawesi need to be known earlier. This study was aim to determine the population density of plant parasitic nematodes associated with several corn planted area in South Sulawesi.

2. Materials and Methods

2.1. Sampling

Sampling was carried out at several centers of corn planted area in South Sulawesi, namely Malakaji (5°26’17.1” Lat. and 119°50’09.8” Long.); Bajeng (5°17’19.3” Lat. and 119°29’45.9” Long.); Bontobili (-5°17’14” Lat and 119°34’12” Long.); Maros (4°59’08.5” Lat. and 119°34’22.5” Long.); and Soppeng (4°30’56.5” Lat. and 119°58’00.1” Long.). The sampling method was done by diagonal sampling technique by taking samples at points along the diagonal lines, namely the middle and fourth corners of the corn plant. Samples taken in the form of soil in the rhizosphere of plant roots. Samples were stored in a plastic bag separately, then stored in a storage box so that it was protected from direct sunlight.

2.2. Extraction of Nematodes from the Soil

Nematode extraction was done by the simple modified Baerman method. 25 g of soil was placed on a small filter coated with filter paper. The filter was placed right on top of a container containing water. The bottom of the filter was tried to touch the surface of the water in the holding glass until the soil was inundated, then incubated for 48 hours. The collected suspension was then filtered using a 500 mesh sieve and inserted into a nematode collection tube. Nematodes in the suspension were observed and calculated under a stereo microscope.

2.3. Making Non-Permanent Preparations

Nematodes were taken using drop pipette and transferred to the glass slide. One drop of 70% alcohol was added to the nematode that has been placed in the glass slide. 70% alcohol is useful for killing nematodes so that it is easier to observe. Then the slide observed under stereo microscope.

2.4. Calculation of Nematode Density

Nematode community density was observed under a stereo microscope. All extracted suspensions were poured into a Petri dish which has been given a boundary line, then the nematodes were calculated under a stereo microscope with 40x magnification with the help of a hand counter. The density calculated was absolute density (total density), density of plant parasitic nematodes, and density of non-plant parasitic nematodes. The observed variables were based on Norton research [5], namely:

1. \( ACD = \frac{n}{100 \text{ ml of soils}} \)

2. \( RCD = \frac{n}{N} \)

3. \( AF = \frac{s}{F} \times 100\% \)

4. \( RF = \frac{AF}{F} \times 100\% \)

5. \( D = \frac{KPA \times \sqrt{AF}}{100} \times 100\% \)
ACD, absolute community density; RCD, relative community density; AF, absolute frequency; RF, relative frequency; F, the frequency of all nematodes; D, the value of dominance; n, Σ nematodes; N, Σ all nematodes; S, Σ all samples; and s, Σ samples containing nematodes.

2.5. Observation of Morphological Character
Morphological observations were carried out by looking at the characteristics of each phase of the development of the nematode. Observations were done under compound microscope and documenting using a camera. Identification was done by referring to the identification book of nematodes [6] and by matching several images in some literature.

3. Results and Discussion

3.1. Abundance of Plant Parasitic Nematodes per 25 Gram of Soil
The nematode community found was dominated by plant parasitic nematodes. The extraction results showed that the abundance of all PPN in corn plantations ranged from 10.60 - 39.66 per 25 gram soil. The results of the observation showed that there were differences in the number of PPN communities at each sampling location. The PPN community in corn planted area in Bontobili showed a very significant difference with other locations. The number of community PPNs (number ± standard deviation) in Bontobili, Maros, Malakaji, Bajeng, and Soppeng were respectively (39.66 ± 6.39), (12.20 ± 11.82), (11.30 ± 10.84), (10.60 ± 6.40), and (10.50 ± 7.46). The dominance of PPN in a community needs attention, because if one species becomes very dominant, it can potentially become an adverse pest.

![Figure 1. Abundance of plant parasitic nematodes in several corn planted areas in South Sulawesi.](image)

3.2. Distribution Frequency
The PPN community was found in all corn planted areas which indicated that the distribution of PPN was relatively high. The highest PPN distribution was in Bontobili with a distribution value of 34.80%, while in Maros, Malakaji, Bajeng, and Soppeng were 17.83%, 16.52%, 15.50% and 15.35% respectively.

The spread of nematodes in an area is strongly influenced by macro and micro climates in the area. In addition to the influence of climate, plant species and ecosystem stability, it also greatly affects the diversity of nematodes. A stable environment, having diverse plants usually has a high diversity of nematode types. Based on observations it was known that several genera of nematodes spread throughout the sampling area. The spread can be affected because the nematodes of the genus above have many hosts, or can survive on the ground without a host for a long time [7; 8; 9; 10].
3.3. Density of Plant Parasitic Nematodes per 100 ml of Soil

The results of the analysis showed that the highest PPN density was in Bontobili, with dominance values reaching 47.60% (Table 1). This is presumably because generally PPNs that are found to have adaptability and survival are quite high and are supported by the availability of hosts at these locations. This is in line with the opinion of Munif [11] that parasitic nematodes have a very wide distribution area, generally have more than one plant host (polyphagous). In addition, the high density of nematodes in the Bontobili area is thought to be due to inadequate cultivation systems, such as the absence of a regular crop rotation system so that the host plant is always available. Abawi and Widmer [12], reported that generally all agricultural practices carried out directly or indirectly influence the incidence and severity of root disease caused by PPN. Environmental compatibility with the availability of adequate hosts allows the PPN to continue to multiply. This is what affects the existence and population of the two nematodes so that the population is different in roots and soil.

Table 1. Density of plant parasitic nematodes in several corn planted areas in South Sulawesi

| Location   | ACD | RCD (%) | AF (%) | RF (%) | D (%) |
|------------|-----|---------|--------|--------|-------|
| Malakaji   | 226 | 16.52   | 100.00 | 29.24  | 22.60 |
| Bajeng     | 212 | 15.50   | 100.00 | 29.24  | 21.20 |
| Bontobili  | 476 | 34.80   | 100.00 | 29.24  | 47.60 |
| Maros      | 244 | 17.84   | 100.00 | 29.24  | 24.40 |
| Soppeng    | 210 | 15.35   | 90.00  | 26.32  | 19.92 |

Note: ACD, absolute community density; RCD, relative community density; AF, absolute frequency; RF, relative frequency; D, the value of dominance
3.4. *Diversity of Plant Parasite Nematode Genus*

The extraction results showed that there were 8 genera of nematodes that had infested corn and spread to several corn planted areas in South Sulawesi (Figure 1). PPN in Bontobili and Malakaji areas were more diverse than other regions, whereas in the Bajeng area only one PPN genus was found, that was *Pratylenchus* spp. In general, the PPN genera was almost present in all locations, except *Meloidogyne* and *Tylenchus* which were only found in Bontobili, and *Aphelenchus* was only found in Maros (Table 2).

![Nematodes Image](image_url)

**Figure 3.** Diversity of nematodes in corn planted areas in South Sulawesi. a, *Helicotylenchus*; b, *Pratylenchus*; c, *Longidorus*; d, *Xiphinema*; e, *Haplolaimus*; f, *Aphelenchus*; g, *Tylenchulus*; h, *Meloidogyne*. 
Table 2. Diversity of plant parasitic nematode genera in several corn planted areas in South Sulawesi

| Genera            | Location          |
|-------------------|-------------------|
|                   | Malakaji  | Bajeng   | Bontobili | Maros | Soppeng |
| Helicotylenchus   | +         | -        | -         | +     | +       |
| Pratylenchus      | +         | +        | +         | -     | -       |
| Longidorus        | +         | -        | +         | +     | -       |
| Xiphinema         | +         | -        | +         | -     | +       |
| Haplolaimus       | +         | -        | -         | +     | -       |
| Aphelenchus       | -         | -        | -         | +     | -       |
| Tylenchulus       | -         | -        | -         | +     | -       |
| Meloidogyne       | -         | -        | +         | -     | -       |

Description: (+) found plant parasitic nematodes; (-) no plant parasitic nematodes were found

It was shown in Table 2 that *Pratylenchus* was the most dominant genus compared to the other genus and was found in three locations that was Malakaji, Bajeng, and Bontobili. Changes in conducive soil environmental conditions can encourage this genus to change status to an adverse pest. According to McDonald and Nicol [13] *Pratylenchus* is a nematode that is a pest that causes serious problems in corn plantations in various countries. These nematodes are cosmopolitan, often found in corn plants whose growth is disturbed. These nematodes attack the fibrous root system; this population of nematodes can be rapidly increased if corn is planted continuously. In Nigeria, the attack of *P. brachyurus* can reduce corn production by 28.5% and damage to plants will be more severe if fungi and/or pathogenic bacteria attack.

4. Conclusion
The highest PPN density was found in the Bontobili area with a dominance value of 47.60%. There were 8 genera of PPN that infested corn and spread to several corn plantations in South Sulawesi, namely *Helicotylenchus, Pratylenchus, Longidorus, Xiphinema, Haplolaimus, Aphelencus, Tylenchus*, and *Meloidogyne*. The results of this study can be used as a basis for monitoring pathogenic attacks on corn by farmers and other researchers.

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