

Review paper

Survey and identification of plant parasitic nematodes on Potato crops in Ethiopia

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A survey was conducted to determine the types, frequency and population of plant parasitic nematode genera associated with the soils and roots from the rhizosphere of potato, during the growing season of 2018. One hundred forty three composite soil and root samples were randomly collected where a modified Baermann technique for plant parasitic nematode extraction was applied. Potato crop grown within four regions i.e. Oromia, SNNP, Amhara and Benishangule-Gumuz revealed the presence of six nematode genera i.e. Meloidogyne, Pratylenchus, Xiphinema, Longidorus, Helicotylenchus and Rotylenchulus were detected. The most dominant nematode genera were Meloidogyne and Xiphinema followed by Longidorus with (20.9%, 15.4%, and 14.7% of frequency of Occurrence respectively). All the six nematode genera were considered as the widely distributed pests of the potato crop within surveyed regions of Oromia and Amhara. Pratylenchus was the only nematode genera that found in all except South Nations Nationalities of People region. The study encourages more research work to establish the economic importance and the management of the reported nematode pests.

Keywords: Nematode; Parasitic; Potato; Survey

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INTRODUCTION

Potato (*Solanum tuberosum L.*) is the world's fourth largest food crop after wheat, rice and maize (Golizadeh and Esmaeili, 2012). Currently, potato is one of the world's prime sources of nutrition which has carbohydrates, fat, protein and mineral. Food and production in the developing countries have almost doubled since 1991, with a corresponding increase in consumption (Hoffler and Ochieng, 2008; FAO, 2008). Potatoes are grown under a wide range of condition through irrigation or rain feed. Ethiopia has good climates and soil types for the production of potato (Endale *et al.*, 2008). Potato is a high potential food security crop in Ethiopia due to its high yield potential and nutritional

quality tuber. In Ethiopia it is a source of income in the house hold, with short growing period and wide adaptability (Ayalew *et al.*, 2014). The Western, central and eastern Ethiopia are good potato producer areas. Total production coverage in Ethiopia about 160,000 ha with national average yield of about 9 tons per hectare, which is much lower than the world average of 15 tons per hectare (Ferdu *et al.*, 2009b, Ayalew *et al.*, 2014). In order to get comparative world average production per hectare Ethiopia need to improve on constraints of production.

Occurrence of several factors contributed in reducing yield/unit of production and quality of produce includes pest and wide range of disease including root-knot nematodes (Eshetu *et al.*, 2006). Various diseases

caused by viruses, bacteria and fungi and insect pests have emerged as serious threat of this crop in the major producing areas. In order to get comparative world average production per hectare Ethiopia need to improve on constraints of production. Therefore, the objective of this study was to identify, document and prioritize major nematode diseases of potato in Ethiopia.

MATERIALS AND METHODS

One hundred forty three composite soil and root samples were obtained from potato plants within rhizosphere zone, for the period of the growing season of 2018. The samples represented four regions i.e Oromia, SNNP, Amhara and Benishangule-Gumuz. Samples were obtained by digging the soil to a distance downward of about 15 cm-30 cm from the rhizosphere of the pepper plants in a systematic, zigzag-sampling pattern of each field. Composite Soil samples of about one kg and 200 g of adventitious roots were positioned in plastic bags and transported directly to the laboratory of nematology at Ambo Agricultural Research Center and reserved in the refrigerator at 4°C awaiting extraction of nematodes (Talwana *et al.*, 2008). Nematode extraction from soil samples was done by sieving and modified Baermann tray method (Goodey JB 1957). Identification of nematode genera in frequent aliquots (1 ml/each) in each soil sample was depended on the morphological characters of the nematode forms according to (Mai *et al.*, 1975). The counting slide was used for determining the number of each nematode genus and recorded. Nematodes were also extracted from roots using a modified maceration and filtration technique according to (Hooper *et al.*, 2005) and thereafter enumerated and identified to genus levels at various magnifications as

described earlier. Nematode specimens from each sample were mounted on glass slides for identification to genus/species level following keys and references of Siddiqi (2006) and (Mekete *et al.* 2012) under a light microscope. Populations of Nematode numbers were expressed as the number of nematodes $J^2/100 \text{ cm}^3$ soil or $J^2/10 \text{ g}$ fresh root weight (FRW) were determined. The prominence value (PV) was calculated as: absolute density $\times \sqrt{\text{absolute frequency of occurrence}/10}$ (De Waele and Jowaan, 2000). Frequency is expressed as the number of sites where a genus occurred. Genera were considered widespread when they occurred in more than 30% of the sites. A genus whose mean density was more than 10 individuals/100 g of root was considered abundant (Adikom, 1988; Khashaija *et al.*, 1994; Talwana *et al.*, 2008).

RESULTS AND DISCUSSION

All one hundred forty three soils and root samples were collected from the roots and rhizosphere of potato crops, through the growing season of 2018. A total of six (6) genera of plant parasitic nematodes belonging to four (4) families were identified from the soil and the root samples in the four regions (Table 1).

These nematode genera were *Meloidogyne*, *Pratylenchus*, *Xiphinema*, *Longidorus*, *Helicotylenchus* and *Rotylenchulus*. Data on Table 2 showed that *Meloidogyne* and *Xiphinema* genera alike to be the widespread nematode pests as they occurred at the rates of 30 and 22 times with frequency of occurrence 20.9 and 15.4%, correspondingly. Furthermore, the two nematode genera *Longidorus* and *Helicotylenchus* showed modest distributions as they occurred at the rates of 21 and 15 times with percent occurrence of 14.7 % and 10.5 % respectively. The genera *Rotylenchulus* was fewer widespread as it occurred at the rate of 8 times with percent occurrence of 5.6% with in surveyed region.

Table 1: Plant parasitic nematodes genera isolated from soils and roots of potato in four regions.

Order	Sub-order	Family	Genus
Tylenchida Dorylaimida	Tylenchina Dorylaimina	Hoplolaimidae	Helicotylenchulus Rotylenchulus
		Pratylenchidae	Pratylenchus
		Heteroderidae	Meloidogyne
		Longidoridae	Longidorus Xiphinema

Table 2: Frequency of occurrence of plant parasitic nematode genera on potato crop

No.	Nematode genera's	Frequency of occurrence of nematode genera on potato crop	
		No	F.O%
1	Meloidogyne	30	20.9
2	Pratylenchus	16	11.2
3	Xiphinema	22	15.4
4	Longidorus	21	14.7
5	Helicotylenchus	15	10.5
6	Rotylenchulus	8	5.6
Total		112	

No=Number of samples containing a genus; F.O=Frequency of Occurrence

The PV of *Helicotylenchus* (155), *Longidorus* (70) and *Xiphinema* (63) was higher from soil samples. The PV of *meloidogyne* was (181) followed by *Pratylenchus* (92) from root samples. When the populations of different PPN genera in soil were evaluated for all mentioned regions, the population density ranged from 57 to 155 nematodes per 100 g of dry soil (Table:3). *Helicotylenchus* had a high mean density of 155 nematodes/100g soil. The predominant genera present were *Helicotylenchus* *Longidorus* and *Xiphinema* across all the regions. The highest PV was recorded from *Helicotylenchus* (155) and *Longidorus* (70) followed by *Xiphinema* (63) from soil samples and *Meloidogyne* (181) from root samples. The lowest PV was recorded from *Rotylenchulus* (57) calculated from soil samples (Table 3). The altitude of the sampled areas ranged from 1384 (Benishangule-Gumuz) to 3284 m (Amhara) region above sea level.

Table 3: Prominence value (PV), frequency of occurrence (FO) and abundance of predominant plant-parasitic nematodes recovered from soils and roots of potato.

Nematode genera	Soil(100cm ³)			Root(10 g)		
	Abundance	FO (%)	PV	Abundance	FO (%)	PV
Meloidogyne	-	-	-	330	30	181
Pratylenchus	-	-	-	229	16	92
Xiphinema	134	22	63	-	-	-
Helicotylenchus	400	15	155	-	-	-
Longidorus	152	21	70	-	-	-
Rotylenchulus	200	8	57	-	-	-

A=Abundance is mean number of individuals of a genus over the sampling sites where the genus was detected.
 Frequency of occurrence (FO %) = number of sites where a genus detected/total number of sites sampled*100.
 Prominence value (PV) = Mean population density *(Frequency of occurrence)^{1/2} *10⁻¹.

All 6 nematode genera were found in Oromia and Amhara region. Among that the highest population of nematode was *meloidogyne* (9900). *Longidorus* (3660) followed by *Xiphinema* (5940) were the highest nematode population found in both regions respectively. *Pratylenchus* nematode is the only nematode recorded from all except SNNP region. The highest nematode population found in the all surveyed region was *Meloidogyne* (9900).The highest nematode population found in the Oromia and Amhara was *Meloidogyne* (181/10gm of root) and *Helicotylenchus* (400/100cm³) of soil respectively.

Table 4: Occurrence of plant-parasitic nematode genera in soil and root samples from 4 major potato growing regions of Ethiopia during the 2018 growing season.

Nematode genera	Oromia,	SNNP	Amhara	B/G/Gumuz
Meloidogyne	+	+	+	+
Pratylenchus	+	-	+	+
Xiphinema	+	+	+	-
Helicotylenchus	+	-	+	-
Longidorus	+	+	+	-
Rotylenchulus	+	-	+	-

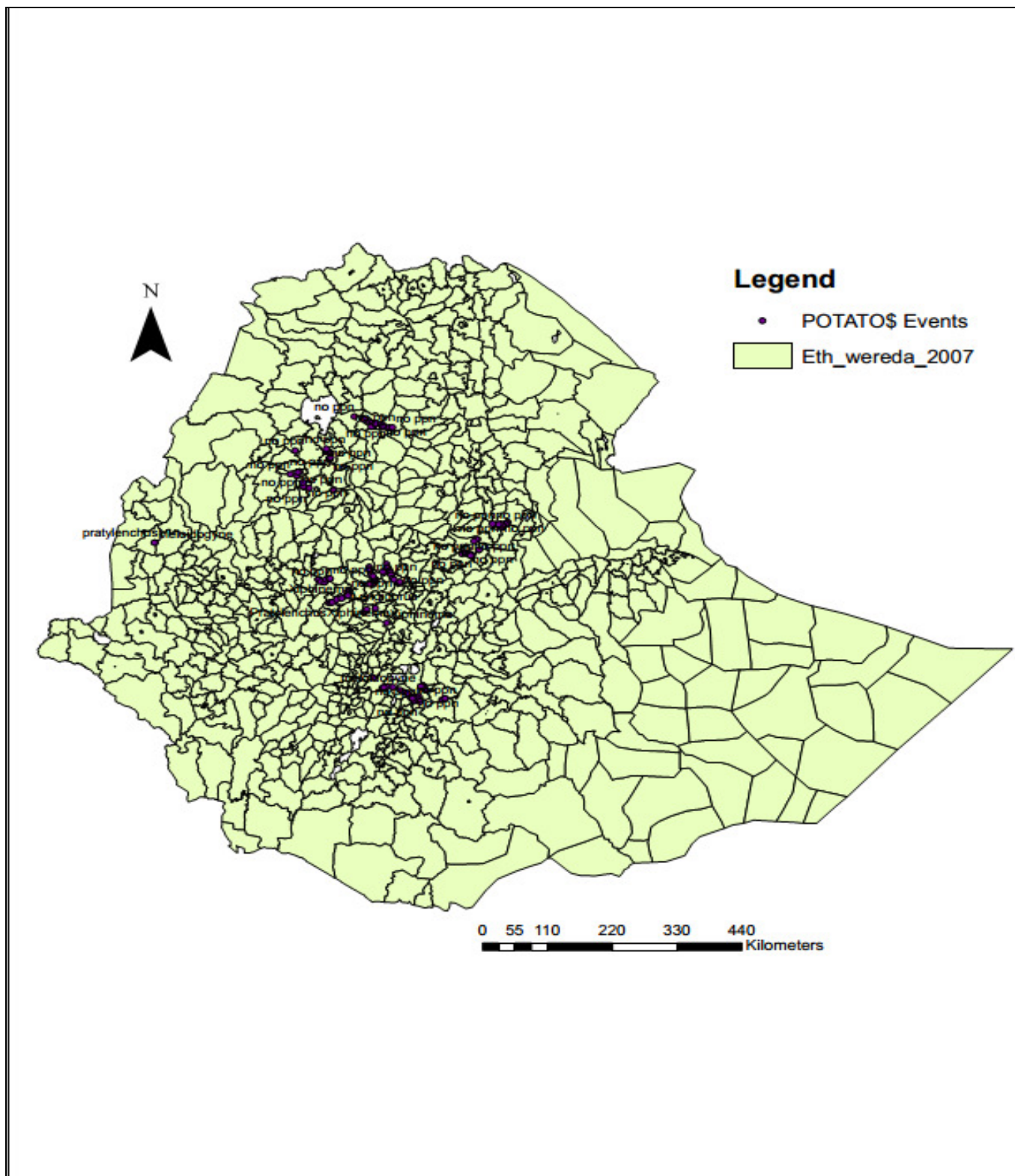


Figure 1. Map showing the major Potato growing districts in Ethiopia, from which root and soil samples were collected during the 2018 growing season.

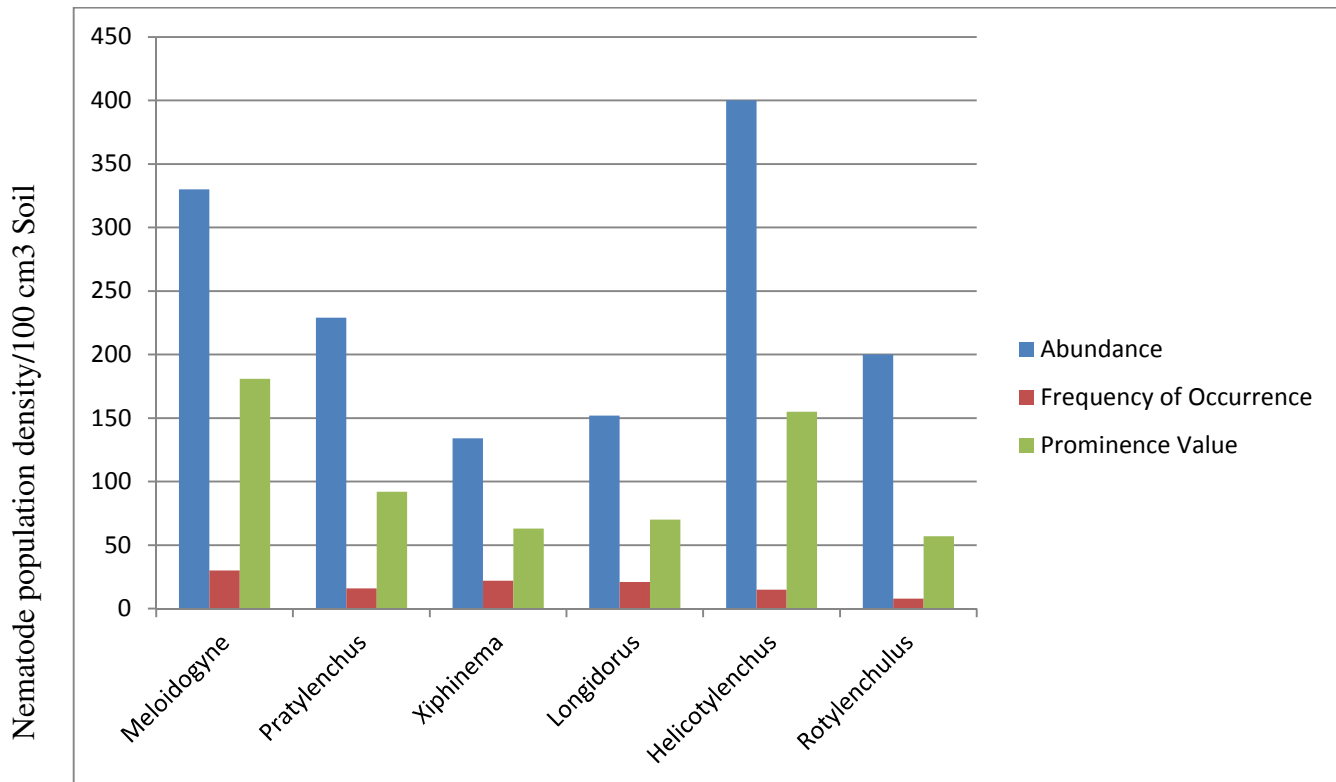


Figure 2. The plant-parasitic nematode abundance, frequency and prominence value recovered from soil samples in all the 4 major potato growing regions of Ethiopia, during the 2018 growing season.

CONCLUSION AND RECOMMENDATIONS

The present study reported the presence of six plant parasitic nematodes genera belonging to 4 families, found associated with the rhizosphere of potato plantations at four regions, Oromia, *SNNP*, Amhara and *Benishan gule-Gumuze*. Among the six phytonematode genera, *Meloidogyne* and *Xiphinema* genera seemed to be the prevailing nematode pests as they occurred at the rates of 30 and 22 times with percent occurrence of 20.9 % and 15.4 %, respectively. Moreover, the nematode genera, *Longidorus* and *pratylenchus* showed modest distributions as they occurred at the rates of 21 and 16 times with percent occurrence of 14.7 % and 11.2 %, respectively, whereas, the genera, *Rotylenchulus* shows less frequent as they occurred at the rate of 8 times with percent occurrence of 5.6 %. In general, the essence of this survey would facilitate in choosing planting systems in the selected locations and evade planting the susceptible hosts, as well as should use in design of nematode management programs.

In Ethiopia, many pests, including nematodes, have been reported as production constraints of cereal, pulse and oil crops (Abate, 1985). Several species of *meloidogyne* genera were found to be widely distributed

on tomato, pepper, onion, snap bean, cabbage, beetroot, carrot and potato (Mandefro & Mekete, 2002). However, the economic importance of these nematodes in relation to yield loss and their impact on national production of these crops still remains unknown.

Plant parasitic nematodes occur in pepper based faming systems in Ethiopia. Higher occurrence and density of major nematode pests such as *meloidogyne* and *xiphinema* may constrain potato production in the country. There is need to establish the economic importance of the reported nematodes in Ethiopia as well as continued search for an effective Plant Parasitic Nematode management strategy in potato based cropping systems.

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