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Survey and Identification of Plant Parasitic Nematodes on Faba bean Crop in Ethiopia

Belay Feyisa*

Ethiopian Institute of Agricultural Research, Ambo Agricultural Research Center, Ethiopia

ABSTRACT

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 faba bean, during the growing season of 2018-2019. One hundred twenty composite soil samples were randomly collected where a modified Baermann technique for plant parasitic nematode extraction was applied. Faba bean crop grown within two regions i.e., Oromia and Amhara revealed the presence of six nematode genera i.e., *Pratylenchus, Rotylenchulus, Tylenchoryhnchus, Xiphinema, Ditylenchus* and *Tylenchus* were detected. The most dominant nematode genera were *xiphinema* followed by *Ditylenchus* with 12% and 7% of occurrence respectively. *Xiphinema* was considered as the widely distributed pest of the faba bean crop as it was associated within all survey regions. The study encourages more research work to establish the economic importance and the management of the reported nematode pests.

Keywords: Faba bean; Nematode; Parasitic; Survey

INTRODUCTION

Faba bean (*Vicia fabae* L.) is the major cool season food legumes produced in Ethiopia next to cereals. It serves as major source of protein and income. The crop also fixes atmospheric nitrogen and improves soil fertility. However, the productivity of faba bean in Ethiopia is still, far below its potential due to a number of factors. Among which diseases are the most important biotic factors causing faba bean yield reduction [1]. An average national productivity is 1.5 tons ha^{-1}, while world average grain yield of faba bean is around 1.8 t ha^{-1} [2]. Pests and diseases of pulses have long been recognized as important constraints to pulses production worldwide and have received extensive research. However, plant parasitic nematodes have remained largely excluded from research attention. Data on the importance of nematodes, particularly individual species occurrence and community composition, population densities and pathogenicity are insufficient. Phytonematode caused considerable injure and losses to different agricultural crops all over the world [3]. Survey studies of such pest play an important role in update economic thresholds for economic crops such as faba bean infection. Pest survey is a vital element of plant quarantine that affords early detection of pest attack, so that their further spread is limited, and timely measures may use for their suppression. Therefore, the present survey was carried-out to determine the plant parasitic nematode genera associated with two important regions of faba bean crops at Oromia and Amhara.

MATERIALS AND METHODS

One hundred twenty soil and root samples were obtained from maize plants within rhizosphere zone, for the period of the growing season of 2018-2019. The samples represented two regions i.e., Oromia and Amhara. Samples were obtained by digging the soil to a distance downward of about 15 cm-30 cm from the rhizosphere of the maize 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 [4]. Nematode extraction from soil samples was done by sieving and modified Baermann tray method [5]. 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 and Lyon [6]. Plant parasitic nematode genera were identified at the generic level [7], and counted using Peter's 1-ml eelworm counting slide under a compound microscope. Nematodes were also extracted from roots using a modified maceration and filtration technique according to Hooper et al. [8] 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 and Mekete et al. [9,10] under a light microscope.

Correspondence to: Belay Feyisa, Ethiopian Institute of Agricultural Research, Ambo Agricultural Research Center, Ethiopia. Tel: +251913443837; Fax: +251-112362325; E-mail: belay22feyisa@gmail.com

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DATA COLLECTION

Populations of Nematode numbers were expressed as the number of nematodes $J^2/100\ cm^3$ soil or $J^2/10$ g fresh root weight (FRW) were determined. The prominence value (PV) was calculated as: absolute density × √absolute frequency of occurrence/10 [11]. 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 [12,13].

RESULTS AND DISCUSSION

All one hundred twenty soils and root samples were collected from the roots and rhizosphere of faba bean plants, through the growing season of 2018. A total of six (6) genera of plant parasitic nematodes belonging to six (6) families were identified from the soil and the root samples in the two regions (Table 1).

These nematode genera were *Pratylenchus, Rotylenchulus, Tylenchoryhnchus, Xiphinema, Ditylenchus* and *Tylenchus*. Data in Table 2 showed that *Xiphinema* and *Ditylenchus* genera alike to be the widespread nematode pests as they occurred at the rates of 14 and 8 times with percent occurrence of 12 and 7%, correspondingly. Furthermore, the two nematode genera *Tylenchorynchus* and *Tylenchus showed* modest distributions as they occurred at the same rates of 6 times with percent occurrence of 5% respectively. The genera *Rotylenchulus* was fewer widespread as they occurred at the rate of 2 times with percent occurrence of 2%.

The PV of *Xiphinema* (59), *Rotylenchulus* (35) and *Ditylenchus* (34) was higher from soil samples. The highest PV were recorded *pratylenchus* (17) followed by *Ditylenchus* (11) and *Tylenchorhynchus* (9) from root samples (Table 3) and (Figure 2) below. Three nematode genera were present in both fababean roots and soils, namely: *Ditylenchus* (bulb and stem), *Pratylenchus* (lesion), and *Tylenchorhynchus* (stunt). The general population density of PPN genera in roots of fababean ranged from 75 to 100 per 10 g of dry roots with *Pratylenchus* and *Tylenchorhynchus* having significantly higher population density of 100 individual per 10 g of roots compared to the other genera. Although *Ditylenchus* spp. *(75)* were present in lower numbers with an average density of less. When the populations of different PPN genera in soil were evaluated for all mentioned regions, the population density ranged from 60 to 250 nematodes per 100 g of dry soil (Table 3). *Rotylenchulus* had a high mean density of 250 nematodes/100g soil. The predominant genera present were *Xiphinema, Ditylenchus* and *Tylenchus* across all the regions. The highest PV was recorded from *Xiphinema* (59) and *Rotylenchulus* (35) followed by *Ditylenchus* (34) from soil samples. The PV of *Pratylenchus* (17) and *Ditylenchus* (11) followed by *Tylenchorhynchus* (9) were calculated from root samples (Table 3). The altitude of the sampled areas ranged from 2176-3086 (Oromia) to 2622-3043 m (Amhara) region above sea level.

All 6 nematode genera except *Rotylenchulus* and *Tylenchorhynchus* were found in Oromia region (Table 4). Among that the highest population of nematode was *Xiphinema* (2400). *Rotylenchulus* nematode is the only nematode recorded from Oromia region. *Ditylenchus* (1800) and *Pratylenchus* (800) followed by *Tylenchus* (700) were the highest nematode population found in both regions respectively. The highest nematode population found in the Amhara region was *Ditylenchus* (800) followed by *Tylenchus* and *Xiphinema* (500) respectively. The highest nematode population found in the Oromia and Amhara was *Xiphinema* (173/100 cm^3) and *Ditylenchus* (400/100 cm^3) of soil respectively. *Xiphinema* was highly distributed in the surveyed region (Figure 1).

The present study reported the presence of six of plant parasitic nematodes genera belonging to 3 families, found associated with the rhizosphere of faba bean crops at two regions, Oromia and Amhara. Among the six phytonematode genera, *Xiphinema* and *Ditylenchus* genera seemed to be the prevailing nematode pests as they occurred at the rates of 14 and 8 times with percent occurrence of 12% and 7%, respectively. Moreover, the nematode genera, *Tylenchorhynchus*

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

Order	Sub-order	Family	Genus
Tylenchida	Tylenchina	Pratylenchidae	*Pratylenchus*
		Hoplolaimidae	*Rotylenchulus*
		Tylenchidae	*Ditylenchus*
		Tylenchorynchidae	*Tylenchorhynchus*
		Tylenchulidae	*Tylenchus*
Dorylaimida	Dorylaimina	Longidoridae	*Xiphinema*

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

Nematode genera's	Frequency of occurrence of nematode genera on faba bean crop	
	No	F.O%
Xiphinema	14	12
Ditylenchus	8	7
Pratylenchus	5	4
Tylenchorhynchus	6	5
Tylenchus	6	5
Rotylenchulus		

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

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

Nematode genera	Soil (100cm^3)			Root (10 g)		
	Abundance	FO (%)	PV	Abundance	FO (%)	PV
Xiphinema	171	12	59	-	-	-
Ditylenchus	150	5	34	75	2	11
Pratylenchus	60	2	5	100	3	17
Tylenchorhynchus	120	4	27	100	0.8	9
Tylenchus	140	5	31	-	-	-
Rotylenchulus	250	2	35	-	-	-

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}.

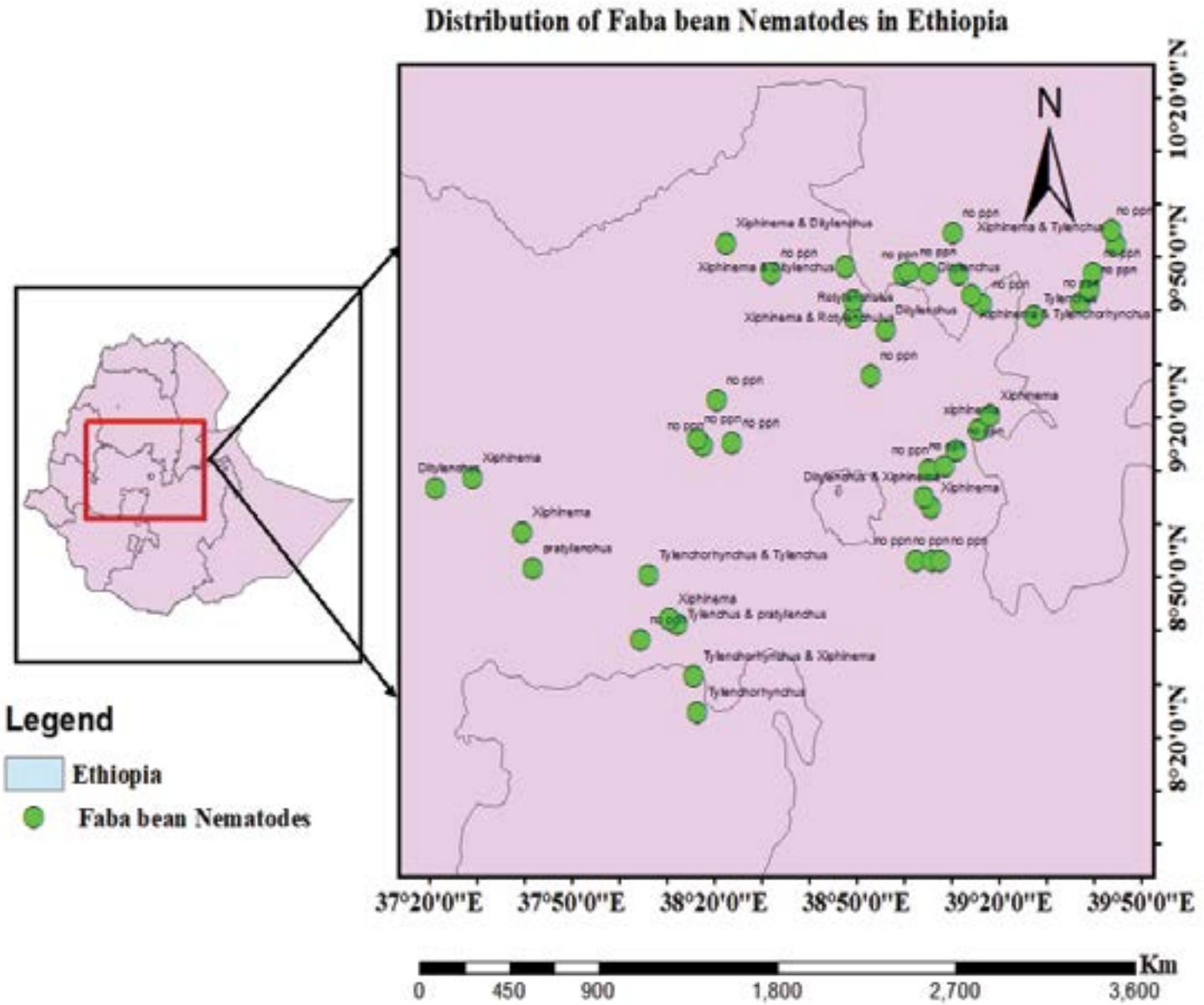

Figure 1: Map showing the major Fababean growing districts in Ethiopia, from which root and soil samples were collected during the 2018-2019 growing season.

and *Tylenchus* showed modest distributions as they occurred at the same rates of 6 times with percent occurrence of 5%, whereas, the genera, *Dotylenchulus* shows less frequent as they occurred at the rate of 2 times with percent occurrence of 5%. Pulse crops such as peas, chickpeas, faba (fava) bean (*Vicia faba* L.), and lentils are among the plants that *Ditylenchus dipsaci* can parasitize or is associated with [14,15]. In Ethiopia, many pests, including nematodes, have been reported as production constraints of cereal, pulse and oil crops [16]. Several species of PPN belonging to 15 genera are reported to be associated with cereals, pulses and oil crops in Ethiopia [17].

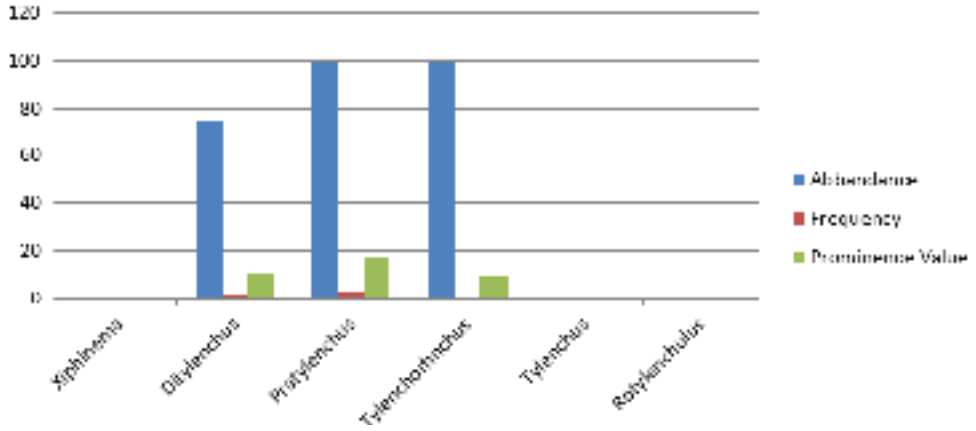

Figure 2: The plant parasitic nematode abundance, frequency and prominence value from root and soil samples in all 2 major fababean growing regions of Ethiopia, during the 2018-2019 growing season.

Table 4: Occurrence of plant-parasitic nematode genera in soil and root samples from 2 major faba bean growing regions of, Ethiopia, during the 2018 growing season.

Nematode genera	*Oromia,*	*Amhara*
Xiphinema	+	+
Ditylenchus	+	+
Pratylenchus	+	+
Tylenchorhynchus	+	-
Tylenchus	+	+
Rotylenchulus	+	-

However, the economic importance of these nematodes in relation to yield loss and their impact on national production of these crops still remains unknown.

CONCLUSION AND RECOMMENDATIONS

Plant parasitic nematodes occur in faba bean based faming systems in Ethiopia. Higher occurrence and density of major nematode pests such as *Xiphinema* and *Ditylenchus* may constrain faba bean 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 faba bean based cropping systems. The study indicated that plant-parasitic nematodes have a large impact on pulse crop production. The occurrence of plant parasitic nematodes in pulse farming systems needs to be investigated further, and the reaction of these nematodes on cultural practices would provide valuable information for management routines.

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