DIVERSITY OF PLANT PARASITIC NEMATODES ASSOCIATED WITH RHIZOSPHERE OF MAIZE FROM DIFFERENT AREAS OF DISTRICT RAJOURI, JAMMU AND KASHMIR, INDIA

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A R T I C L E   I N F O

A B S T R A C T

Diversity of plant parasitic nematodes in the rhizosphere of maize (*Zea mays*) from some areas of District Rajouri, Jammu and Kashmir was studied. A total of ten plant parasitic nematode species were found to be associated with the rhizosphere of maize plants in these areas. The nematode species were *Pratylenchus zeae, P. brachyurus, Helicotylenchus dihystera*, *Longidorus brevicaudatus*, *L. elongatus*, *Xiphinema diversicadatum, X. elongatum, Tylenchorhynchus* spp. *Ditylenchus* spp. and *Criconemoides* spp. The most dominant and frequently occurring species was found to be *P. zeae,* with absolute frequency of 86.66% followed by *P. brachyurus* (80%), *H. dihystera*, (76.66%) and *L. brevicaudatus* (73.33). Contrarily, the least frequent was *Criconemoides* spp. (36.66%) followed by *Tylenchorhynchus* spp. and *Ditylenchus* spp. with absolute frequencies of 53.33% and 60%. Similar trend was observed in case of relative frequencies. In case of *P. zeae,* mean density of 56 and relative density of 16.05% was observed followed by *P. brachyurus* and *H. dihystera* with mean densities and relative densities of 50.33, 14.43% and 49, 14.04% respectively. On the other hand, *Criconemoides* spp. and *Tylenchorhynchus* spp. showed mean densities of 6.33 and 23.33 and absolute densities of 1.81% and 6.68% respectively. *P. zeae* exhibited high prominence value of 57.85 followed by *P. brachyurus* (49.96). The least prominence value was found in *Criconemoides* spp. (4.05) followed by *Tylenchorhynchus* spp. with prominence value of 18.30.

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INTRODUCTION

Maize (*Zea mays* L.) is a cereal grain and is the third most important cereal crop in the world as well as in India. It belongs to the grass family Poaceae*.* It was first grown by people in ancient Central America. In India, the crop covers an area of about 8.67 million hectares. Under the ISOPAM maize production programme, the production and productivity in India has increased to

22.26 million tons and 2566 kg/ha respectively during 2012-2013. Maize is cultivated in many parts of India like Karnataka, Maharashtra, Andhra Pradesh, Bihar etc. However, several factors limit the growth and production of maize which include both biotic and abiotic factors. Among the biotic factors, nematodes that feed on roots are one of the big stresses and limit the growth of maize and lead to heavy yield losses. The effects of parasitic nematodes on production of grain corn have been well studied (Norton, 1983, 1984; Windham, 1998). Although, several nematode species live in association within maize rhizosphere, maize cyst nematode (*Heterodera zeae*) is considered as one of the most important nematode pests of maize in India and abroad (Eisenback et al., 1993; Singh and Rathore, 2001). *H. zeae* was first reported by Koshy et al. (1970) from Chhapli village of Rajsamand district of Rajasthan. Walters (1979a, 1979b) published the first manuscript on nematodes associated with maize. The manuscript reports the extent of damage caused by plant parasitic nematodes on maize. The main factors that subject maize crops to nematode pests are low organic matter contents of soils and monoculturing of maize crop. Before 1995, *Pratylenchus* was generally perceived as the economically most important nematode pest genus that infected maize (De Waele and Jordaan, 1988; Jordaan et al., 1989; Louw, 1982; Walters, 1979a, 1979b; Zondagh and Van Rensburg, 1983). In India, Singh et al. (2007) reported various phytonematodes associated with maize viz. *Heterodera, Pratylenchus, Tylenchorhynchus, Meloidogyne, Hoplolaimus, Helicotylenchus, Rotylenchus, Longidorus, Trichodorus, Xiphinema and Belonolaimus*. According to Singh and Rathore (2001), *H. zeae* is known as the most important and frequently occurring nematode of maize crop. The annual yield losses of maize caused by this nematode is 17-29 % in India (Srivastava and Chawla, 2005).

Plant parasitic nematodes heavily damage the crops and decrease the yield drastically. As maize is the staple food in Dhanore, Dhanidar, Kapakha, Chowdhary-naad, and Palma areas of District Rajouri, therefore, the aim of this work was to assess the diversity and occurrence of plant parasitic nematodes associated with the rhizosphere of maize from these areas.

MATERIALS AND METHODS

Survey and sample collection: A survey was conducted during May, 2019 for studying the diversity of nematodes associated with maize from different areas viz. Dhanore, Dhanidar, Kapakha, Chowdhary-naad, and Palma of District Rajouri (33.3717° N, 74.3153° E), Jammu and Kashmir. About 30 samples were collected from rhizosphere of maize along with roots in air tight plastic bags. The collected samples were taken to the laboratory for sieving and isolation of nematodes.

Isolation of nematodes from soil: The samples were processed by Cobb's sieving and decanting method (Cobb, 1918) and Baermann funnel technique (Southey, 1986). The roots were cut into small pieces and then subjected to maceration with the help of mortar and pestle. The nematodes from the root paste were isolated by modified Baermann funnel technique (Hooper et al., 2005). After 12-24 hours, few water drops were taken from rubber tubing of Baermann funnel in a cavity block and observed under stereomicroscope. The nematodes were counted using Syracuse dish. For the identification of nematodes, temporary slides were made and studied under Olympus BX51 compound microscope.

Community analysis: For community analysis following parameters were calculated by using different formulae (Norton, 1978; Tomar et al., 2006).

Frequency
= Number of samples in which the specimen was present

Absolute frequency
$$= \frac{\text{Number of samples containing the specimen}}{\text{No. of samples collected}} \times 100$$

Relative frequency
$$= \frac{\text{Frequency of species(N)}}{\text{Sum of frequencies of all specimens present in samples}} \times 100$$

Density
$$= \frac{\text{No. of specimens of given species counted in all samples}}{\text{No. of samples collected}} \times 100$$

Relative density
$$= \frac{\text{Density of the specimen}}{\text{Sum of densities of all the nematode specimens}} \times 100$$

Prominence value of species
$$= \text{Relative density} \times \sqrt{\text{Relative frequency}}$$

RESULTS AND DISCUSSION

Frequency of nematodes: A total of ten plant parasitic nematode species were found to be

associated with the rhizosphere of maize fields in District Rajouri of Jammu and Kashmir. These identified species are *Pratylenchus zeae, P. brachyurus, Helicotylenchus dihystera*, *Longidorus breviannulatus, L. elongatus Xiphinema diversicadatum, X. elongatum,* *Tylenchorhynchus* spp. *Ditylenchus* spp. *Criconemoides* spp. Among these, *P. zeae* was found to be the most abundant species followed by *P. brachyurus.* The least abundant species were *Criconemoides* spp. and *Tylenchorhynchus* spp. (Figure 1).
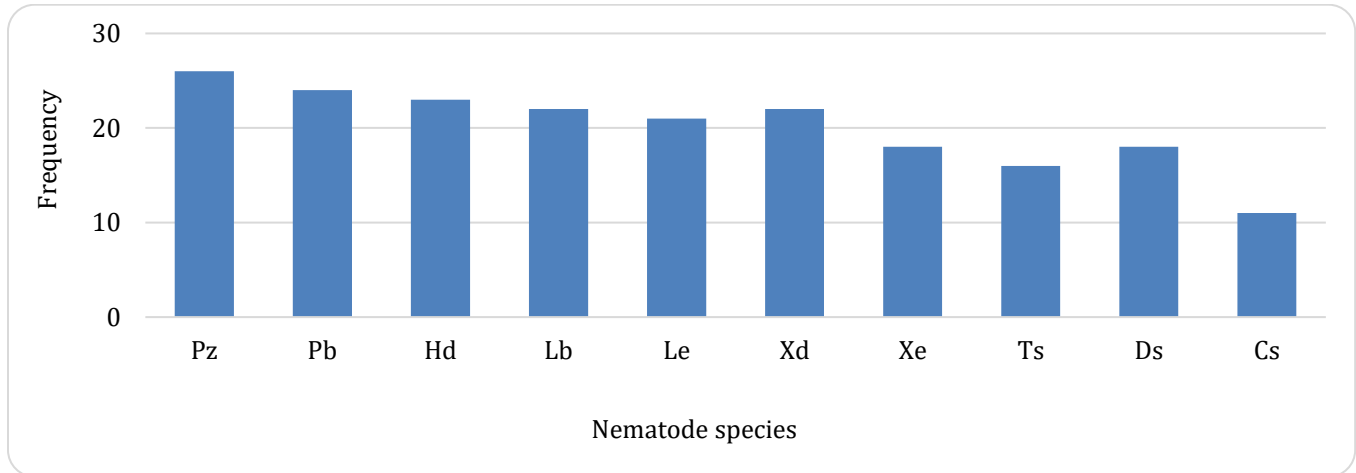

Figure 1. Frequencies of different nematode species in district Rajouri.
Pz = *Pratylenchus zeae,* **Pb** = *P. brachyurus,* **Hd** = *Helicotylenchus dihystera*, **Lb** = *Longidorus brevicaudatus*, **Le** = *L. elongatus*, **Xd** = *Xiphinema diversicadatum,* **Xe** = *X. elongatum,* **Ts** = *Tylenchorhynchus* spp. **Ds** = *Ditylenchus* spp. and Cs = *Criconemoides* spp.

Absolute and relative frequencies: The most dominant and frequently occurring species was found to be *Pratylenchus zeae,* with absolute frequency of 86.66%. This was followed by *P. brachyurus* (80%), *Helicotylenchus dihystera*, (76.66%) and *Longidorus brevicaudatus* (73.33).

The least frequent was *Criconemoides* spp. (36.66%) followed by *Tylenchorhynchus* spp. and *Ditylenchus* spp. with absolute frequencies of 53.33% and 60% (Figure 2). Similar trend was observed in case of relative frequencies as shown in figure 3.
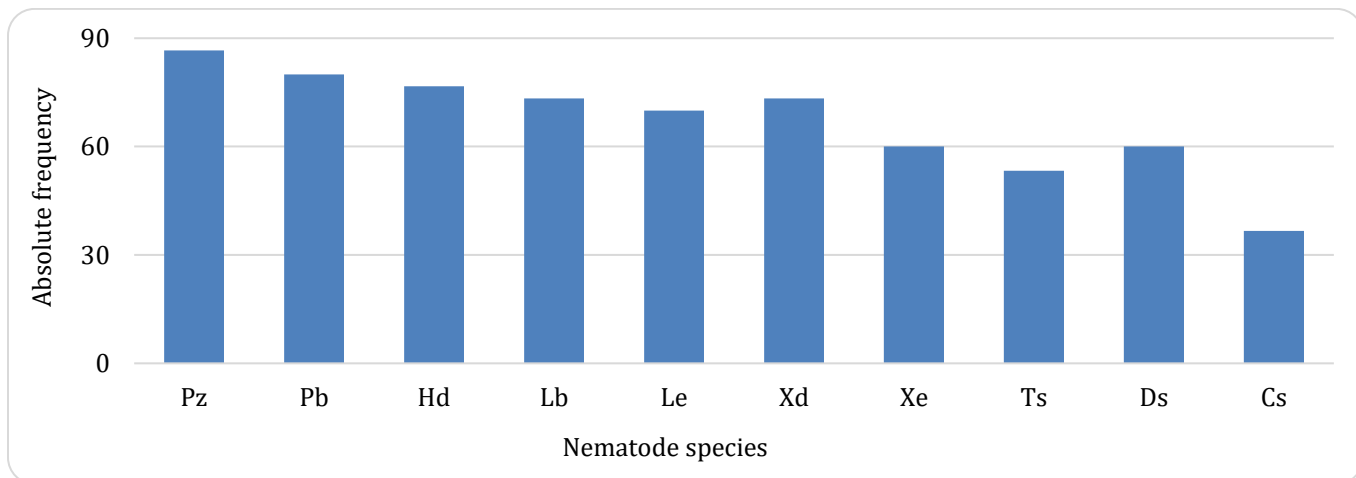

Figure 2. Absolute Frequencies of different nematode species in district Rajouri.
Pz = *Pratylenchus zeae,* **Pb** = *P. brachyurus,* **Hd** = *Helicotylenchus dihystera*, **Lb** = *Longidorus brevicaudatus*, **Le** = *L. elongatus*, **Xd** = *Xiphinema diversicadatum,* **Xe** = *X. elongatum,* **Ts** = *Tylenchorhynchus* spp. **Ds** = *Ditylenchus* spp. and Cs = *Criconemoides* spp.
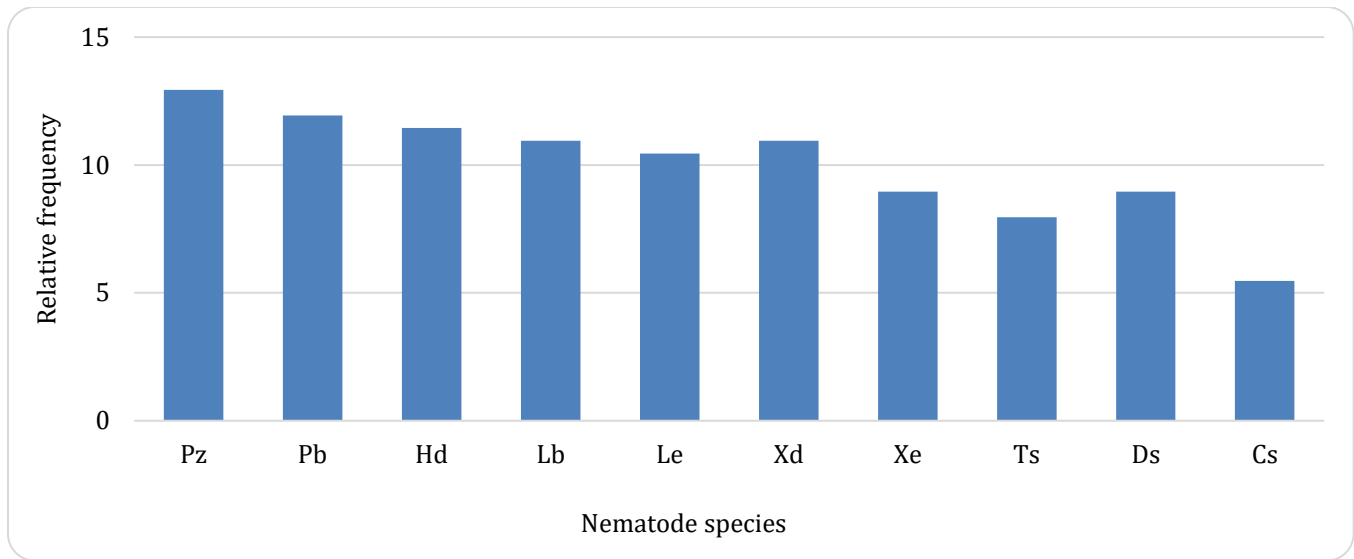
Figure 3. Relative frequencies of different nematode species in district Rajouri.
Pz = *Pratylenchus zeae,* **Pb** = *P. brachyurus,* **Hd** = *Helicotylenchus dihystera*, **Lb** = *Longidorus brevicaudatus*, **Le** = *L. elongatus*, **Xd** = *Xiphinema diversicadatum,* **Xe** = *X. elongatum,* **Ts** = *Tylenchorhynchus* spp. **Ds** = *Ditylenchus* spp*.* and Cs = *Criconemoides* spp*.*

Density and relative density: *P. zeae,* was the most dominant species with mean density of 56 and relative density of 16.5%. This was followed by *P. brachyurus* and *H. dihystera* with mean densities and relative densities of 50.33, 14.43% and 49, 14.04% respectively. The least dominant was *Criconemoides* spp*.* and *Tylenchorhynchus* spp. with mean densities of 6.33 and

23.33 and absolute densities of 1.81% and 6.68% respectively (Figure 4 and 5).
Prominence value: *P. zeae* exhibited high prominence value of 57.85 followed by *P. brachyurus* (49.96*).* The least prominence value was found in *Criconemoides* (4.05) followed by *Tylenchorhynchus* spp. with prominence value of 18.30 (Figure 6).
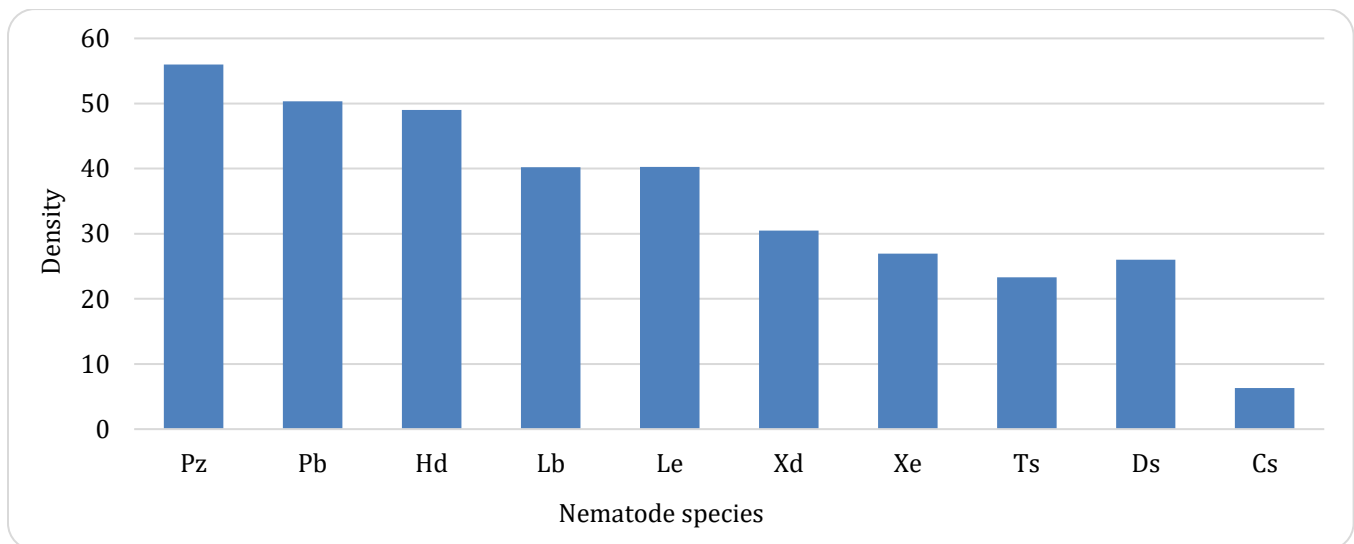

Figure 4. Densities of different nematode species in district Rajouri.
Pz = *Pratylenchus zeae,* **Pb** = *P. brachyurus,* **Hd** = *Helicotylenchus dihystera*, **Lb** = *Longidorus brevicaudatus*, **Le** = *L. elongatus*, **Xd** = *Xiphinema diversicadatum,* **Xe** = *X. elongatum,* **Ts** = *Tylenchorhynchus* spp. **Ds** = *Ditylenchus* spp*.* and Cs = *Criconemoides* spp*.*
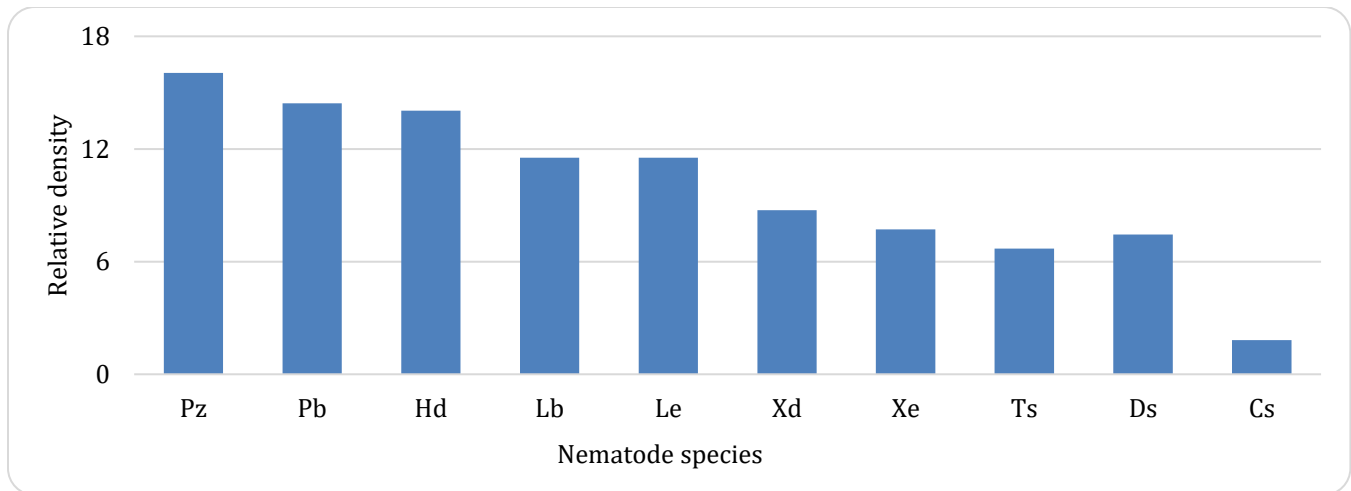
Figure 5. Relative densities of different nematode species in district Rajouri.
Pz = *Pratylenchus zeae,* **Pb** = *P. brachyurus,* **Hd** = *Helicotylenchus dihystera*, **Lb** = *Longidorus brevicaudatus*, **Le** = *L. elongatus*, **Xd** = *Xiphinema diversicadatum,* **Xe** = *X. elongatum,* **Ts** = *Tylenchorhynchus* spp. **Ds** = *Ditylenchus* spp*.* and Cs = *Criconemoides* spp*.*

Figure 6. Prominence values of different nematode species in district Rajouri.
Pz = *Pratylenchus zeae,* **Pb** = *P. brachyurus,* **Hd** = *Helicotylenchus dihystera*, **Lb** = *Longidorus brevicaudatus*, **Le** = *L. elongatus*, **Xd** = *Xiphinema diversicadatum,* **Xe** = *X. elongatum,* **Ts** = *Tylenchorhynchus* spp. **Ds** = *Ditylenchus* spp*.* and Cs = *Criconemoides* spp*.*
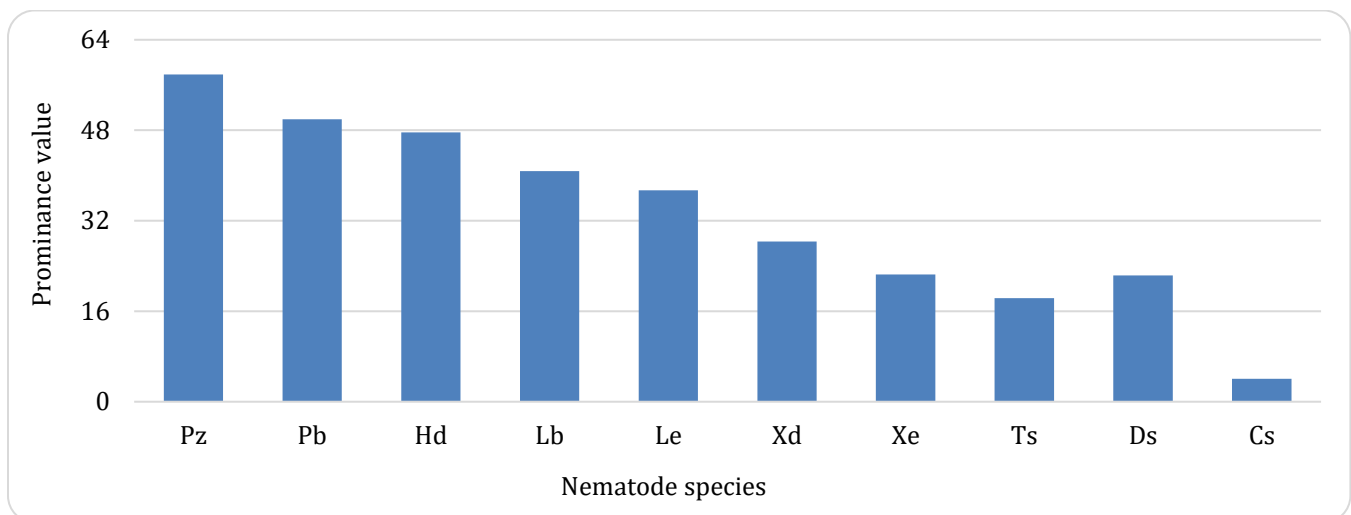
The frequent occurrence of genera *Helicotylenchus, Pratylenchus and Ditylenchus* agrees with the observations of De Waele and Jordaan (1988), McDonald and Nicol (2005). The most abundant and dominant was *P. zeae.* According to De Waele and Jordaan (1988) and McDonald and Nicol (2005), in tropics *P. zeae* is a serious pest and one of the most common lesion nematode of maize. *X. elongatum, Tylenchorhynchus* spp. and *Criconemoides* spp*.* were less abundant and prevalent.

Being the most widespread and present in ample number, *P. zeae* is the major plant-parasitic nematode of maize in Dhanore, Dhanidar, Kapakha, Chowdhary- naad, and Palma areas of District Rajouri of Jammu and Kashmir.

CONCLUSION
From the above results, it is concluded that maize fields in Dhanore, Dhanidar, Kapakha, Chowdhary- naad, and Palma areas of District Rajouri of Jammu and Kashmir

are heavily parasitized by phytophagous nematodes. Increase in nematode number, diversity and abundance is directly proportional to increase in crop loss and the crop yield will be heavily affected. To control these nematodes, the basic and the best management tool is crop rotation. The susceptible crop like maize should be followed by non-host crops. The application of synthetic nematicides like carbofuran is another way to limit the number of these nematodes in these areas.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHORS' CONTRIBUTION

KAA, SMW and KAB designed and executed the study. KAA, KAB, NK and RUN analyzed the data and prepared the manuscript, AAS edited the manuscript. All the authors approved the final manuscript.

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