Original Research

Research on Crop Ecophysiology
Vol.15/2, Issue 2 (2020), Pages: 63 - 68

The Effect of Crop Rotation on the Diversity and Abundance of Plant Parasitic Nematodes in Potato Fields

ESMAEIL MAHMOUDI*, ALIREZA JALALIZAND, SHAHRBANOO JAHANGIRI
Department of Plant Protection, faculty of Agriculture, Isfahan (Khorasgan) Branch, Islamic Azad University, Isfahan, Iran

*Correspondence author: e.mahmoudi@khuisf.ac.ir

Received: 8 March 2020 Accepted: 10 APRIL 2020

ABSTRACT
In order to identify the plant parasitic nematodes of potato fields in Western and central regions of Isfahan province, 45 soil and root samples were collected from rhizosphere and aerial parts of potatoes during 2018 and 2019. The nematodes were extracted by combined sieving and centrifugal-flotation method of Jenkins and transferred to glycerin by using DeGrisse method. The permanent slides were prepared and the nematodes were studied by light microscopy. In this research, 20 species from nineteen genera belonging to Tylenchina and Aphelenchina suborders were identified as follows: *Amplelimerlinius sp., Aphelenchoides limberi, Aphelenchus avenae, Boleodorous thylactus, Ditylenchus destructor, Filenchus filiformis, Filenchus polyhypnus, Haplolaimus galeatus, Helicotylenchus vulgaris, Irantylenchus sp., Merlinius brevidens, Neopsilenchus magnidens, Paratylenchus similis, Pratylenchoides ritteri, Pratylenchus neglectus, Psilenchus iranicus, Rotylenchus iranicus, Scutylenchus rugosus, Tylenchus davainei, Zygotylenchus guevarai.* The species *Helicotylenchus vulgaris*, and *Irantylenchus sp.* were measured with 58 and 2 percent frequency, respectively. In this research, the asterisk species were the new records for potato nematode fauna of Isfahan province.

Key Words: *Irantylenchus sp*. Plant parasitic nematode, Potato

INTRODUCTION

Crop rotation is one of the old agricultural practices in improvments of soil physical, chemical and biological properties, that it plays an important role in the microbial balance of the soil and reducing the population of plant pathogens (Jalli *et al.,* 2021). Plant parasitic nematodes are one of the most important plant pathogenic agents in agricultural products, which due to their direct role in weakening the host plant, creating a favorable environment for the attack of other plant pathogenic agents, and the transmission of some viral pathones, should have been the attention of those involved in the production of agricultural products (Agrios, 2005).

The most important destructive nematodes in potatoes are golden cyst nematode (*Globodera pallida* and *G. rostochiensis*), root knot nematode (*Meloidogyne spp.*), and tuber and stem rot nematode (*Ditylechus dipsaci* and *D. destructor*) and root wound nematode (*Pratylenchus sp.*) (Figueiredo *et al*., 2022; Orlando *et al*., 2020). Tanha Maafi *et al.* (2004) was introduced *Pratylenchus sp.* as potato endo-parasitic nematode in Tehran, Shahrood and west Azarbayjan provinces. Damadzadeh and Akhiani (1989) investigated the population changes of *Pratylenchus neglectus* and *Meloidogyne javanica* in Chaharmahal Bakhtiari potato fields. Gitty *et al.* (2011) reported *Pratylenchus thornei* from potato fields in Hamedan province and it seems that this nematode is more widespread in Hamedan fields.

Potato cyst nematodes are quarantine restricted pests of potato causing major yield and financial losses to farmers. In order to mitigate the potato cyst nematode threat in potato production, the establishment of the level of infestation, their geographical distribution, and the agronomic and social factors that could be influencing their distribution and spread are essential toward establishing and implementing a national management strategy (Mburu *et al.*, 2020)

Considering that conducting basic research is the way forward for applied research in the field of managing plant pathogens, and that potatoes are one of the strategic crop of Isfahan province, and every year a large amount of seed tubers was imported from other regions of the country into Isfahan, which may introduce new nematodes into the potato fields. Therefore, monitoring studies for population changes of plant parasitic nematodes in potato cultivation areas are particular importance in order to monitor this important agricultural pest (Imren, 2018). This research was aimed to identify important plant parasitic nematodes in potato fields, and also to evaluate the diversity and dominant population of parasitic nematodes in the western regions of Isfahan province.

MATERIALS AND METHODS

Sampling and isolation of nematodes

During the spring and summer of 2018 and 2019, soil and root samples were taken from potato fields in the western regions of Isfahan province (Fereydan and Fereydounshahr counties).

For sampling, three points in each field were randomly selected and the surface soil was removed and about 500 grams of soil was taken from a depth of 5 to 15 cm and mixed. Then, from the total volume of soil, one kilogram was taken as a sample and put into plastic bags, and after recording the characteristics of the farm, host, sampling time, etc., they were taken to the laboratory. A total of 45 soil samples and 5 potato root samples were collected.

Separation of nematodes from soil was done by sieve (60, 230 and 400 mesh) and centrifuge method (Jenkis, 1964). In order to prepare a slide of nematodes, first they were killed by De Grisse method (1969) and after fixing, a permanent slide was prepared.

Identification of nematodes

Identification of nematodes was done based on nematological keys (Kargar and Garrett 1998; Hassanzadeh *et al.,* 2014; Ghaderi *et al.,* 2014). For this purpose, morphometric characteristics such as: L- body length in microns; a - the ratio of body length to the largest body width; b- the ratio of body length to esophagus length (from head to cardia valve); b'- the ratio of the body length to the distance from the head to the end of the esophageal glands (in the case of overlap between the esophagus and the intestine); c- the ratio of body length to tail length; 'c - the ratio of the length of the tail to the width of the body in the area of the anus; v- the ratio of the distance between the head and the vulva to the body length in percent; T- the ratio of the length of the testis from the cloaca to the body length; st - the length of the stylet in microns; m- the ratio of the length of the conical part of the stylet to the total length of the stylet in terms of percentage and etc., were used. Identification of nematode species was done using Nikon YS200 microscope. For quantification of nematodes population, the total population of parasitic nematodes was counted in different soils using McCartney Bottles (Bahmani *et al.,* 2014; Zafar *et al*., 2007)

RESULTS AND DISCUSSION

In this research, 20 species of plant parasitic nematodes belonging to 19 genera of the Tylenchida order were identified from a total of 45 soil and root samples of potato fields that were collected from fifteen different regions of this crop cultivation (Table 1). The species, *Helicotylenchus vulgaris*, *Ditylenchus destructor* and *Pratylenchus neglectus* had the highest distribution and abundance among the identified nematodes. As well as, these three species showed wide host range and were isolated in most of the soil samples in different crops.

The eight species including *Aphelenchoides limberi*, *Aphelenchus avenae*, *Irantylenchus sp.*, *Paratylenchus similis*, *Pratylenchoides ritteri*, *Psilenchus iranicus*, *Rotylenchus iranicus* and *Scutylenchus rugosus* were collected for the first time from potato fields in Isfahan province.

Nematode species collected from different regions had different frequency percentages. The largest population of isolated nematodes is related to *Helicotylenchus vulgaris* species in the samples collected from Nenadegan fields with bean-potato crop rotation. This species is more abundant than other species in other soils. For example, in the samples with fallow-potato rotation, the frequency was 50%, and in the Namagerd sample, with potato-barley rotation, the frequency was 60 percentages (Table 2).

Table 1- Plant parasitic nematodes isolated from potato fields and in rotation crop with it

No.	Nematode species	Sampling location	crops in rotation
1	*Filenchus filiformis*	Daran, Nemagerd, Boein Miandasht	Potatoes, onions, wheat, beans
2	*Filenchus polyhypnus*	Namagerd, Damaneh, Daran	Potatoes, alfalfa, wheat
3	*Ditylenchus destructor*	All regions	Potatoes, corn
4	*Pratylenchus neglectus*	Namagard, Afous, Nanadegan	Potatoes, beans, wheat
5	*Haplolaimus galeatus*	Afous, Damaneh	Corn, potatoes, barley, wheat
6	*Merlinius brevidense*	Namagerd, Gharghan, Ghafar, Daran	Wheat, potatoes, onions, corn
7	*Helicotylenchus vulgaris*	All regions	Potatoes, wheat, onions, alfalfa, barley
8	*Amplelimerlinius sp.*	Namagerd, Ashjerd, Boein Miandasht	Potatoes, corn
9	*Aphelenchus avenae*	Nanadegan, Seftejan, Daran, Boein Miandasht	Wheat, potatoes, alfalfa
10	*Scutylenchus rugosus*	Afous, Chigan, Ghudjanak	Wheat, potatoes, alfalfa
11	*Boleodorous thylactus*	Nanadegan, Ghudjanak, Gahle-Malek	Potato
12	*Rotylenchus iranicus*	Nanadegan, Seftejan	Corn, potatoes, alfalfa
13	Tylenchus davainei	Namagerd, Ashjerd, Boein Miandhash	Potatoes, wheat
14	*Neopsilenchus magnidens*	Daran	Potatoes, barley, wheat
15	*Pratylenchoides ritteri*	Namagerd, Nahrkhalaj, Chigan, Ghafar, Daran	Corn, alfalfa, wheat
16	*Aphelenchoides limberi*	Chigan, Gharghan, Ghale-Malek	Corn, potatoes
17	*Irantylenchus sp.*	Namagerd	Corn, potatoes
18	*Zygotylenchus guevarai*	Afous, Chigan, Ghudjanak	Wheat, alfalfa, beans
19	*Paratylenchus similis*	Namagerd, Damaneh, Daran	Alfalfa, barley, potatoes
20	*Psilenchus iranicus*	Damaneh, Nemagerd, Nanadegan	Potatoes, barley, onions

Table 2. Abundance of plant parasitic nematodes in major sampling regions

No.	Nematode Genus	Frequency (%)	Sampling location	Crop
1	*Ditylenchus*	35	Namagerd	Potato, Wheat
2	*Helicotylenchus*	60	Namagerd	Potato, Barely
3	*Merlinius*	40	Afous	Fallow, Potato
4	*Irantylenchus*	2	Namagerd	Corn, Potato
5	*Helicotylenchus*	68	Nanadegan	Bean, Potato
6	*Ditylenchus*	58	Gharghan	Potato, Barely
7	*Pratylenchus*	6	Daran	Wheat, Onion
8	*Aphelenchus*	56	Daran	Potato, Wheat
9	*Neopsylenchus*	3	Ghudjanak	Alfalfa, Corn
10	*Aphelenchus*	50	Nahrkhalaj	Potato, Potato

The lowest frequency related to *Irantylenchus sp.* in the Namagerd sample, with 2 percentage frequency. Also, the potato tuber rot nematode (*D. destructor*) was isolated from all investigated areas and the highest frequency was 58% in Gharghan fields with potato-barely crop rotation. This nematode is one of the most important potato parasites and according to the report of the Mediterranean and European Botanical Organization (EPPO), it is present in more than 70% of the potato cultivation areas of the world (EPPO, 2005; Taheri *et al.,* 2013). In Japan, 18 plant species, including *Brassica chinensis*, *Cucumis sativus*, *Cucurbita moschata*, and *Capsicum annuum*, in addition to potato, have been introduced as hosts for this nematode. The presence of weeds in potato fields, as well as in fields that are rotated with this crop, increases the rate of tuber rot nematode infection by 25% (Kardol 2007).

The genera *Paratylenchus*, *Hoplolaimus*, *Helicotylenchus*, *Aphelenchoides* and *Pratylenchus* are among the best-known potato and alfalfa nematodes (Hassanzadeh *et al.*, 2014; Figueiredo *et al.*, 2022), and in the present study, these nematodes were observed in most potato fields, especially in fields with alfalfa-potato rotation, with a high percentage of abundance. *G. rostochiensis* which known as golden cyst, yellow cyst and golden nematode of potato is one of the most destructive and damaging potato nematodes in most parts of the world and can destroy up to 100% of the product (Mburu *et al*., 2020; Gitty *et al.*, 2011). This nematode was a part of Iran's quarantine pest list until 2007 and did not exist in our country. Unfortunately, due to the out-of-control and non-technical import of seed and food potato tubers from infected countries, this nematode entered the country and its infection was observed and confirmed for the first time at 2007 in a number of potato field in Hamedan province (Gitty *et al.* 2011). In this research, all sampled areas were carefully examined and fortunately, no infectious cases of this nematode was observed. Fereydan county is one of the important areas for production of seed potato in Isfahan and Iran, and every year a lot of potatoes which are produced in this region, are exported to other province such as Khuzestan, Ardabil, Hamedan and Lorestan as seed potatoes. Contamination of this area with potato cyst nematode can be a serious threat to the production of potatoes and the contamination of other areas were this product is grown.

In conclusion, the diversity of identified parasite nematodes in different soils shows that crop rotation between plants that are common hosts for parasitic nematodes causes the stability of nematodes in the soil and increases their population. Also, the population of nematodes with a wide host range was high in most soils, which indicates the crop rotation had no effect in reducing their population.

REFERENCES

Agrios GN. 2005. Plant Pathology 5th ed. Academic Press, San Diego, 705 P.

Bahmani J, Barooti S, Ghaderi R. 2014. Occurrence of *Paratylenchus labiosus* Anderson & Kimpinski, 1977 (Nematoda: Tylenchulidae) in Iran, with discussion on the validity of the species. Journal of Crop Protection, 3(3): 273- 281.

De Grisse AT. 1969. Redescription ou modification de quelques techniques utilisées dans Létude des nematodes phytoparasitaires. Melded Rijksfaculteit der landbouwetenschappen Gent, 34: 351-369.

EPPO. 2005. Situation of several quarantine pests in Lithuania in 2004: first report of rhizomania. EPPO Report Service, No. 5: 75.

Figueiredo J, Vieira P, Abrantes I, Esteves I. 2022. Commercial Potato Cultivars Exhibit Distinct Susceptibility to the Root Lesion Nematode *Pratylenchus penetrans*. Horticulture, 8: 244.

Ghaderi R, Karegar A, Niknam G. 2014. An updated and annotated checklist of the Dolichodoridae (Nematoda: Tylenchoidea) of Iran. Zootaxa, 3784 (4): 445-468

Gitty M, Tanha maafi Z, Arjmandian A, Pisheva S. 2011. Occurrence of Potato Golden Cyst Nematode in Iran and its Distribution in Hamadan Province. Agricultural Biotechnology, 2(1): 53-61.

Hassanzadeh Z, Kargar A, kheiri A. 2014. Species of Tylenchida nematodes collected from alfalfa fields in Hamadan province. Plant Pathology Journal, 41: 663-686

Imren M. 2018. Determination of Plant Parasitic Nematodes in Potato Growing Areas in Bolu Province. Uluslararası Tarım ve Yaban Hayatı Bilimleri Dergisi (UTYHBD), 4(2): 187 – 192.

Jalli M, Huusela E, Jalli H, Kauppi K, Niemi M, Himanen S and Jauhiainen L. 2021. Effects of Crop Rotation on Spring Wheat Yield and Pest Occurrence in Different Tillage Systems: A Multi-Year Experiment in Finnish Growing Conditions. Frontiers in Sustainable Food Systems, 5: 647335. doi: 10.3389/fsufs.2021.647335

Jenkins WR. 1964. A rapid centrifugal flotation technique for separating nematodes from soil. Plant Cell Reporter 48: 692.

Kardol P. 2007. Plant and soil community assembly in secondary succession on ex-arable land. Fundamental and applied approaches. PhD thesis, Wageningen University, 208 pp.

Karegar A, Geraert E. 1998. The genus *Filenchus* Andrássy, 1954 (Nemata: Tylenchidae) from Iran. Species with four lateral lines. Journal of Nematode Morphology and Systematics, 1: 1-22.

Mburu H, Cortada L, Haukeland S, Ronno W, Nyongesa M, Kinyua Z, Bargul JL and Coyne D. 2020. Potato Cyst nematodes: A New Threat to Potato Production in East Africa. Frontiers Plant Sciences, 11:670.

Orlando V, Grove IG, Edwards SG, Prior T, Roberts D, Neilson R, Back M. 2020. Root-lesion nematodes of potato: Current status of diagnostics, pathogenicity and management. Plant Pathology, 69: 405–417

Taheri MZ, Tanha Maafi Z, Subbotin SA, Pourjam E, Eskandari A. 2013. Molecular and phylogenetic studies on Pratylenchidae from Iran with additional data on *Pratylenchus delattrei*, *Pratylenchoides alkani* and two unknown species of *Hirschmanniella* and *Pratylenchus*. Nematology, 15: 633-651.

Tanha Maafi Z, Amini F, Parvizi R. 2004. Endoparasite nematodes and population density in potatoes field of Tehran and West Azarbayejan provinces, Plant Pathology Journal, 41: 425-435.

Zafar AH, Khan A, Islam S. 2007. A key and diagnostic compendium to the species of the genus *Merlinius* Siddiqi, 1970 (Nematoda: Tylenchida) with description of *Merlinius khuzdarensis* n. sp. associated with date palm. Nematology, 9(2): 251-260