



Research Article

Plant Parasitic Nematodes (Nematoda: Tylenchida, Aphelenchida) Associated with Strawberry (*Fragaria ananassa* Duch) Fields in the Northern Region of Kyrgyzstan

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Abstract | Strawberry (*Fragaria* L.) cultivation is widely practiced in Kyrgyzstan, where agriculture plays a significant role in the economy. Plant parasitic nematodes (PPN) are serious pests of several plants worldwide including straw berry. So far, no record of any plant parasitic nematode (PPN) exists detailing the species found in strawberry growing areas of Kyrgyzstan. This research aimed to provide a faunistic and taxonomic record of PPNs from soil and plant samples collected from strawberry orchards in 10 different locations in Tokmok area of northern Kyrgyzstan during the summer of 2016. PPNs were identified according to morphological and morphometric characters. Eight species belonging to the orders Tylenchida and Aphelenchida (Nematoda) were identified: *Bitylenchus dubius*, *Boleodorus thylactus*, *Filenchus filiformis*, *Helicotylenchus digonicus*, *Merlinius brevidens*, *Pratylenchus neglectus*, *Psilenchus hilarulus* (Nematoda: Tylenchida) and *Aphelenchoides fragariae* (Nematoda: Aphelenchida). The most common species were *H. digonicus* and *M. brevidens*. This is a first record for all obtained species from strawberry growing areas in Kyrgyzstan. Moreover, 3 plant parasitic species (*B. dubius*, *H. digonicus* and *A. fragariae*) were revealed for the first time in the agricultural areas of Kyrgyzstan and among these, *A. fragariae* (strawberry foliar nematode) is a very important pest of strawberry.

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Keywords | Nematoda, Plant parasitic nematodes, Occurrence, Strawberry, Kyrgyzstan

Introduction

1.3 million hectares of Kyrgyzstan's 10.9 million hectares of land consists of agricultural lands. The agricultural sector in Kyrgyzstan is dominantly owned by private and small family businesses. Sixty-five percent of the people in Kyrgyzstan live in rural areas and approximately 30% of the total population work in the agricultural sector. Wheat, barley, corn, potatoes, melons, oil crops, vegetables and fruit crops are the main crops grown (Uluu *et al.*, 2018). Strawberry (*Fragaria ananassa* Duch) is an economically important fruit in Kyrgyzstan.

Traditionally, plants grown in soil are vulnerable to plant parasitic nematode (PPN) attack. Acceptably, plants grown in an environment with mixed microbiology such as soil are impacted by more than a single organism group under natural conditions; hence, crop losses due to PPNs for instance are difficult to estimate.

The strawberry foliar nematode *Aphelenchoides fragariae* (Nematoda: Aphelenchida), inflicts damage upon plants from 47 families and more than 250 species including strawberries, lily, African violet, chrysanthemum, fern, begonia, violets, primroses,

azaleas, etc. It is believed to reduce strawberry yield up to 60%. Ornamental plants are also hosts (Duggan, 1969). This nematode species was first detected in strawberry plants in England in 1889 (Decker, 1989). *A. fragariae* severely impacts strawberry plants in many countries (Mor and Spiegel, 1993; Riedel and Powel, 1974; Hunter *et al.*, 1974; Noel, 1994). It has been reported mainly in temperate or warm climate regions of Asia, Australia, Europe, North and South America (Christie, 1959).

Unlike many other PPNs that infect roots, foliar nematodes are obligate parasites of the aboveground parts of plants. In the absence of the host plant, these nematodes can survive by feeding on saprophytic fungi (Richardson and Grewal, 1993). Strawberry foliar nematode feeds on the parenchyma, mesophyll and epidermis tissues of leaves as ectoparasitic or endoparasitic (Maggenti, 1981; Decker, 1989). Strawberry leaf nematode over winter as adults and larvae in the soil and plant leaves. Nematodes begin to migrate from soil to leaf through a thin film of water (Jagdale and Grewal, 2006; Buckley and Gould, 2003).

Current control methods are ineffectual in the elimination of PPNs from contaminated areas under quarantine and reasons such as the high cost of chemical control methods and their toxicity to the environment, have necessitated the use of alternative control methods. In this respect, environmental pest control requires the inspection of soil for the presence of harmful nematodes. Besides identifying the species, it is necessary to determine its density and then to put forward the control strategies.

This study as a first aimed to determine the PPN species found in strawberry (*Fragaria* L.) producing areas in Kyrgyzstan. A previous study on the detection of root-knot nematodes (*Meloidogyne* spp.) in the 2016 production season revealed the presence of *M. incognita* and *M. javanica* in vegetable and fruit planting areas with strawberry, bean and apricot in Talas and Tokmok agricultural areas in the northern part of Kyrgyzstan. This was a new record for these root-knot nematode species in Kyrgyzstan (Kepenekci and Döklötkeldiyeva, 2017c). This study and Kepenekci and Döklötkeldiyeva (2017c) point out that more nematological studies in other strawberry growing areas in Kyrgyzstan are necessary especially on the detection of strawberry leaf nematode (*A. fragariae*) and root-knot nematodes (*Meloidogyne* spp.), which

are quarantine pests.

Materials and Methods

A total of ten soil and plant samples were collected from strawberry production areas (Talas, Tokmok and Meenetkech) in the North of Kyrgyzstan in 2016 to identify PPN species belonging to the order Tylenchida and Aphelenchida (Nematoda) (Figure 1).



Figure 1: Map of Kyrgyzstan; showing sampling sites in the major of strawberry production region, Kyrgyzstan.

These soil and plant samples were taken from strawberry production areas in Tokmok and Meenetkech regions (Kyrgyzstan) around the time adult nematode populations were high (June and July 2016). Plant roots and soil samples were collected after every 10-50 steps in a zig-zag pattern from sampled fields and placed in polyethylene bags. The samples were stored in ice boxes at 4°C and brought to the laboratory where they were kept in the refrigerator at the same temperature until further examination in the laboratory.

The modified “Baermann funnel” method was used to extract active nematodes in soil (Christie and Perry, 1951). With this method, nematodes in 10 ml of water obtained from 200 cm³ soil samples were collected, fixed using the method developed by De Grisse (1969) and identified at the genus level. After species identification, permanent preparation was made with the “wax-ring” method (Hooper, 1986). In addition, the rate of detection and prevalence of the nematodes was presented according to the distribution of the species in the samples.

Identification of PPNs obtained from the samples was done using classical methods (diagnostic keys) from morphological and morphometric features of nematodes. Imaging-measuring system was used in the study and the measurements were made using 20

individuals (female and male) for species with high density, whereas for species with low density the number of individuals available was used.

Results and Discussion

This study detected 8 plant parasitic nematode species from 8 different genera belonging to Tylenchida and Aphelenchida (Nematoda) orders from sampled soil; these species were *Bitylenchus dubius*, *Boleodorus thylactus*, *Filenchus filiformis*, *Helicotylenchus digonicus*, *Merlinius brevidens*, *Pratylenchus neglectus*, *Psilenchus hilarulus* (Nematoda: Tylenchida) and *Aphelenchoides fragariae* (Nematoda: Aphelenchida) The most common species were *H. digonicus* and *M. brevidens*. The systematic places of the detected species are given according to Siddiqi (2000) (Table 1).

All the species encountered in the study are new records for strawberry growing areas in Kyrgyzstan and moreover, three species (*B. dubius*, *H. digonicus* and *A. fragariae*) in particular are reported for the first time from Kyrgyzstan agricultural areas. *H. digonicus* was the most prevalent species with 80%, followed by *M. brevidens* with 60%. *A. fragariae* (strawberry nematode), one of the least species encountered (10%) in the study, is an important quarantine pest for strawberry.

One of the first studies on plant parasitic nematode (PPN) species in strawberry growing areas of Kyrgyzstan was on the prevalence of root-knot nematodes (Kepenekci and Döklökeldiyeva, 2017c). So far, no data available of PPNs associated with strawberry growing areas of Kyrgyzstan. The nematodes belonging to the order Tylenchida namely, *Aphelenchoides*, *Aphelenchus*, *Criconema*, *Ditylenchus*, *Gracilicus*, *Helicotylenchus*, *Paratylenchus*, *Pratylenchus*,

Tylenchorhynchus and *Tylenchus* have been reported earlier (Yıldız et al., 2021).

In 2016, a survey was conducted from the bean cultivation areas in the Kyrgyzstan s and identified 16 species belonging to 12 genera from the order Tylenchida. Isolated nematodes were *Bitylenchus duplexa*, *Boleodorus thylactus*, *Ditylenchus dipsaci*, *D. myceliophagus*, *Filenchus filiformis*, *F. thornei*, *Helicotylenchus dihystrera*, *Hoplolaimus galeatus*, *Irantylenchus claviformis*, *Merlinius brevidens*, *Paratrophurus loofi*, *Pratylenchus neglectus*, *P. pratensis*, *P. thornei*, *Psilenchus hilarulus* and *Quinisilcius capitatus*. This was the first inclusion of these species into the fauna of Kyrgyzstan (Kepenekci and Erdoğan, 2017b). In a study conducted in potato cultivation areas of Kyrgyzstan, it was reported that 6 species belonging to 4 families and 6 genera belonging to the order Tylenchida were identified. These species were *Bitylenchus goffarti*, *Ditylenchus destructor*, *Filenchus cylindricus*, *Helicotylenchus vulgaris*, *Rotylenchus buxophilus* and *Scutylenchus rugosus*. It has been noted that all detected species are new records for Kyrgyzstan (Kepenekci et al., 2021). Another study on PPN, root-knot nematode species viz., *Meloidogyne incognita* and *M. javanica*, present in vegetable and fruit planting areas in Talas and Tokmok agricultural areas in northern Kyrgyzstan, detected, as a first, *Meloidogyne incognita* and *M. javanica* in strawberries, beans and apricots areas (Kepenekci and Döklökeldiyeva, 2017c). As for cyst nematodes (*Heterodera* spp.), soil samples were collected from sugar beet and wheat cultivation areas, which are widely grown in Talas and Tokmok agricultural areas, during 2016 production season, the *H. schachtii* was detected from sugar beet fields, and the *H. avenae* from wheat. This was a new record for these species (cyst nematodes) for the fauna of Kyrgyzstan (Kepenekci et al., 2017d).

Table 1: Plant parasitic nematode (PPN) species belonging to the orders Tylenchida and Aphelenchida (Nematoda), the number found in samples and their detection rate in samples taken from the north of Kyrgyzstan strawberry growing areas.

Nematode species	Number of samples	Percentage of occurrence (%)
<i>Helicotylenchus digonicus</i> Perry, in Perry, Darlind and Thorne	8	80.0
<i>Merlinius brevidens</i> (Allen) Siddiqi	6	60.0
<i>Bitylenchus dubius</i> (Bütschli)	2	20.0
<i>Boleodorus (Boleodorus) thylactus</i> Thorne and Malek	2	20.0
<i>Filenchus filiformis</i> (Bütschli) Meyl	1	10.0
<i>Pratylenchus neglectus</i> (Rensch) Filipjev and Schuurmans Stekhoven	1	10.0
<i>Psilenchus hilarulus</i> deMan	1	10.0
<i>Aphelenchoides fragariae</i> (Ritzema-Bos) Christie	1	10.0

Nematological studies conducted on VVNs in Kyrgyzstan in 2016 reported 4 economically important nematode species from 3 genera and 3 subfamilies (Longidorinae, Xiphinematinae and Trichodorinae) of the orders Dorylaimida and Triplonchida after analysis of samples taken from Kyrgyzstan. These species identified for the first time were *Longidorus elongatus* in sugar beet, *L. macrosoma* in apricot, *Xiphinema diversicaudatum* in strawberry and *Trichodorus similis* in potato fields. All these species were new reports for the Kyrgyzstan fauna (Kepenekci and İmren, 2017a).

A study investigated the status of EPNs belonging to Steinernematidae and Heterorhabditidae families in potato and apricot production areas in Talas and Tokmok regions in Kyrgyzstan in 2016 and found that 7% of the soil samples were positive (totally 41 samples) for EPNs. Based on morphometric and molecular data, the species obtained from soil samples were *Heterorhabditis bacteriophora* (KG81 isolate) and *Steinernema feltiae* (KG3 isolate). This study was the first report on the presence of EPNs in Kyrgyzstan (Kepenekci et al., 2017e).

Park et al. (2003) assessed the occurrence and population density of PPNs in large strawberry growing regions in Korea's Gyeongbuk and Chonbuk provinces and revealed 10 plant parasitic nematode species viz., *Aphelenchoides fragariae*, *Criconeoides morgensis*, *Ditylenchus dipsaci*, *Helicotylenchus dihystrera*, *Hirschmanniella imamuri*, *Meloidogyne arenaria*, *M. incognita*, *Pratylenchus penetrans*, *Psilenchus hilarulus*, and *Tylenchorhynchus clayton*. The authors also determined the density and frequency of variability of each species from one field to another. In another study, soil and root samples taken from strawberry production areas in the Brazilian state of Paraná in the 2017 production season were examined for PPNs and *Helicotylenchus dihystrera*, *Meloidogyne hapla*, *M. javanica* and *Pratylenchus brachyurus* species were identified. *Scutellonema*, *Ditylenchus*, *Hemicycliophora*, *Mesocriconema* and *Trichodorus* were found at low densities (Krezanoski, et al., 2020). Samaliev and Mohamedova (2011) assessed the presence of strawberry-related PPNs in the strawberry fields of Bulgaria (Plovdiv, Blagoevgrad, Ruse, Vratza and Sofia), and identified nematodes from 15 species and 10 genera belonging to the orders Tylenchida and Dorylaimida in soil and root samples. *Aphelenchoides fragariae*, *A. ritzemabosi*, *A. besseyi*, *Criconema*

nutabile, *Ditylenchus dipsaci*, *Helicotylenchus dihystrera*, *Longidorus caespiticola*, *L. elongates*, *Meloidogyne arenaria*, *M. hapla*, *Pratylenchus penetrans*, *P. microdorus*, *Pratylenchus pseudoparietinus*, *Tylenchorhynchus claytoni* and *Xiphinema pachtaicum* were the species detected (Samaliev and Mohamedova, 2011).

Conclusions and Recommendations

This research provides information about the presence and density of PPNs species in strawberry producing areas of Kyrgyzstan. The presence of *A. fragariae* in such areas poses a risk and growers need to take the necessary precautions to prevent its increase and spread into other areas. Other nematode species identified in this survey are not regarded as dangerous pests for strawberry plants. Based on this study and Kepenekci and Döklötkeldiyeva (2017c), more nematological studies in other strawberry growing areas in Kyrgyzstan are necessary especially on the detection of strawberry leaf nematode (*A. fragariae*) and root-knot nematodes (*Meloidogyne* spp.), which are quarantine pests.

Novelty Statement

This research provides information about the presence and density of PPN species in strawberry producing areas of Kyrgyzstan. All the species detected in the study are new records for strawberry growing areas in Kyrgyzstan.

Author's Contribution

İlker Kepenekci: Main primary author who conducted the study by collection of samples, performed practical research work, identification, writing of article.

F. Dolunay Erdoğuş: Supervise in identification.

Adnan Tülek: Supervise in writing of article and in identification.

Conflict of interest

The authors have declared no conflict of interest.

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