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A Survey for Plant-Parasitic Nematodes Associated with Ginseng (*Panax ginseng* C.A. Meyer)

Ki Chae Chung*, So Deuk Park**†, Zakaullah Khan**, and Bok Jin Kim***

*Poongki Ginseng Experiment Station, Gyongbuk Provincial ATA, Korea.
**Seongju Fruit-Vegetable Experiment Station, Gyongbuk Provincial ATA, Korea.
***Department of Agriculture, Youngnam University, Daegu, Korea.

ABSTRACT : A survey was conducted during April~May 2004 to determine the occurrence and population density of plant-parasitic nematodes in ginseng (*Panax ginseng* C.A. Meyer) growing fields, in major ginseng growing regions of Chungbuk, Chungnam, Gyeongbuk and Kyongki provinces. The survey revealed presence of eleven species of plant-parasitic nematodes namely, *Criconemoides morgensis, Ditylenchus destructor, Helicotylenchus dihystera, Meloidogyne incognita, M. hapla, Paratylencgus lepidus, Pratylenchus penetrans, Psilenchus hilarulus, Trichodorus similis, Tylenchorhynchus claytoni* and *Xiphinema americanum*. Frequency and density of each species were highly variable. *M. incognita* and *M. hapla* were the predominant species, their infestation observed in 46.3 and 39.4% fields with an average density of 78~254 and 76~211 nematodes per 300 ㎤ soil, respectively. Whereas, *T. similis* and *X. americanum* were rarely observed; only in 2.3 and 1.8% of surveyed fields and their density was 10~17 and 7~10 individuals per 300 ㎤ soil, respectively. They are recorded herewith for the first time from ginseng fields of Korea. In nematode-infestated fields, stunted plant growth with chlorotic leaves, and wilted plants were observed in patches.

Key words : *Panax ginseng*, Korea, plant-parasitic nematodes, survey

INTRODUCTION

Ginseng (*Panax ginseng* C.A. Meyer) is a slow-growing perennial plant that belongs to the Araliaceae family. It is a medicinal plant cultivated for obtaining its highly valued root. It is widely cultivated in Korea where the climate and soil are proper for producing the world's finest ginseng. Ginseng is considered as an important agricultural commodity in Korea; its cultivation spread over 13,000 ha with average yield of 1,015 tons/ha (Ministry of Agriculture and Forestry, Korea, 2002). Some plant-parasitic nematodes are known to be harmful pest of ginseng (Anonymous, 1999). Nematode parasitism may result in secondary infection by soil-borne fungal and bacterial pathogens (Sikora & Carter, 1987) or transmission of plant viruses (Brown *et al.*, 1995).

Chemical nematicide use is one of the primary means of control for plant-parasitic nematodes. However, the potential negative impact on the environment and ineffectiveness after successive use have led to a total ban or restricted use of most nematicides and an urgent need for safe and effective options (Zuckerman & Esnard, 1994). As a result, there has been increased interest in the development of other effective and environmentally friendly methods for controlling nematodes including breeding of resistant plants and crop rotations. To better understand this it is important to acquire information on the occurrence of nematodes, their host range, initial population density in fields, and pathogenic potentials. Although comprehensive lists of nematode

† Corresponding author : (Phone) +82-54-931-6788 (E-mail) psd2222@hanmial.net
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pests in medicinal plants and their distribution have been compiled in Korea (Kim *et al.*, 1987; Choi & Park, 1991; Park *et al.*, 1993; 1998a, 1998b), there is no detailed data available on ginseng, which is needed to form a guide line for management and future research. Therefore, this survey was conduct to determine and document the occurrence, distribution, density and prevalence of plant-parasitic nematodes in ginseng fields of Korea.

MATERIALS AND METHODS

A survey was conducted in 218 fields in major ginseng growing regions of Chungbuk, Chungnam, Gyeongbuk and Kyongki provinces of Korea (Table 1). Soil and root samples were collected in April-May 2004. Each soil sample was composite of 8~10 soil cores from one field, collected to a depth of 20 ㎝ with a hand shovel. Samples were placed in plastic bags, sealed and brought back to the laboratory and stored at 5℃ until nematode extraction. Roots were washed free of soil and examined for galling and root-knot infection. Mature females of root-knot nematodes were dissected out from the infected roots and perineal pattern were prepared for species identification as described by Taylor & Netschler (1974). Each soil sample was thoroughly mixed by shaking the plastic bags and nematodes extracted from 300 ㎤ soil by centrifugation-floatation (Jenkins, 1964). Isolated nematodes were killed in hot water (70℃) and fixed in 4% formalin and placed in vials. Prior to nematode counting, vials containing nematodes suspension were agitated thoroughly and an aliquot (3 ㎖) was poured to counting dish. Nematodes were counted under 10x magnification using an inverted microscope.

Selected specimens for each of the recorded species were dehydrated by Seinhorst's (1959) rapid glycerin method and mounted on plastic slide in anhydrous glycerin. Nematodes were measured under microscope under 100x magnification using an ocular micrometer. *Meloidogyne* species were identified on the basis of female perineal patterns and morphological characters of males and second stage juvenile according to Eisenback (1985). Other species of plant parasitic nematodes were identified on the morphology and measurements of adults (Esser, 1973; Handoo, 2000; Choi, 2001; Handoo & Golden, 1989).

RESULTS AND DISCUSSION

Eleven species of plant-parasitic nematodes were detected in association with ginseng cultivation in the different localities of Chungbuk, Chungnam, Gyeongbuk and Kyongki provinces of Korea (Table 1). The frequency and density of all recorded species were highly variable in different localities and within the locality from field to field (Table 1). *Meloidogyne incognita* (Kofoid & White) Chitwood and *M. hapla* Chitwood were the predominant species and their infestation were detected in 46.3 and 39.4% fields with average population density of 76~211 nematodes per 300 ㎤ soil; respectively; followed by *Paratylenchus lepidus* Pinochet & Raski and *Ditylenchus destructor* Thorne found in 26.6 and 22.9% fields with population density of 38~79 and 32~56 nematodes, respectively. *Tylenchorhynchus claytoni* Steiner also recovered from 18.8% fields with density of 24~53 nematodes. *Criconemoides morgensis* (Hofmnner) Taylor and *Pratylenchus penetrans* (Cobb) Filipjev & Schuurmans were found in 11.5 and 6.0% fields with density of 16~41 and 18~36 nematodes, respectively. *Helicotylenchus dihystera* (Cobb) Sher and *Psilenchus hilarulus* de Man were isolated from 3.2% fields, with density of 11~18 nematodes per 300 ㎤ soil, each. *Trichodorus similis* Seinhorst and *Xiphinema americanum* (Cobb) were observed with the least frequency and density, 2.3 and 1.8% with population density of 10~17 and 7~10 nematodes per 300 ㎤ soil, respectively, and recorded as the first identification in ginseng fields of Korea.

This survey provides information on occurrence and density of plant-parasitic nematodes associated with ginseng cultivation in Korea. During survey it was observed that ginseng growth was highly variable in most of the surveyed fields. Stunted and chlorotic plants appeared in patches, indicating symptoms associated with nematode problems in ginseng fields. Enlarged tumor-like swellings or galls along the root

Table 1. Relative frequency of occurrence and mean population density of the species of plant-parasitic nematodes in 300 ㎤ soils collected from ginseng growing fields

Nematode	C. mor.		D. des.		H. dih.		M. inc.		M. hap.		P. lep.		P. pen.		P. hil.		T. sim.		T. cla.		X. ame.	
Locality	RF	MD	RF	MD	RF	MD	RF	MD	RF	MD	RF	MD	RF	MD	RF	MD	RF	MD	RF	MD	RF	MD
Chungbuk Pro.[y]																						10
Dansan (10)[z]	-	-	-	-	10	16	40	169	50	123	-	-	-	-	-	-	10	17	20	35	10	7
Danyang (14)	-	-	28.6	39	-	-	57.1	254	-	-	35.7	35	21.4	36	-	-	-	-	35.7	28	-	-
Eumseong (11)	-	-	-	-	-	-	-	-	54.5	121	36.4	55	-	-	9	12	-	-	-	-	-	-
Chungnam Pro[y]																						
Geumsan (13)	-	-	46.2	42	-	-	53.8	166	46.2	211	38.5	44	-	-	-	-	-	-	-	-	-	-
Jidong (15)	33.3	35	-	-	-	-	53.3	134	60	178	46.6	79	20	30	-	-	13.3	16	46.7	38	-	-
Gyeongbuk Pro[y]																						
Anjeong (9)	33.3	41	-	-	-	-	66.6	184	-	-	44.4	42	22.2	24	-	-	-	-	-	-	22.2	10
Bonghwa (13)	-	-	38.5	40	15.4	18	61.5	160	38.6	76	-	-	-	-	-	-	-	-	30.8	24	-	-
Munkyeong (12)	-	-	50	32	-	-	41.7	87	58.3	206	-	-	-	-	16.7	12	-	-	-	-	-	-
Poongki (14)	-	-	42.9	47	-	-	50	172	64.3	177	50	47	-	-	14.2	18	-	-	-	-	-	-
Seobeok (11)	-	-	-	-	-	-	-	-	63.6	188	36.4	40	27.3	20	-	-	-	-	45.5	29	-	-
Sunheung (10)	30	25	-	-	-	-	60	176	-	-	40	35	-	-	-	-	-	-	-	-	-	-
Yeocheon (12)	-	-	41.6	33	-	-	66.7	213	-	-	-	-	16.7	18	-	-	-	-	-	-	8.3	8
Yeongpoong (13)	30.8	32	-	-	-	-	53.8	187	38.5	98	-	-	-	-	-	-	-		30.6	38	-	-
Yeorok (10)	-	-	40	40	20	15	-	-	60	151	50	38	-	-	20	11	20	10	-	-	-	-
Kyongki Pro[y]																						
Anseong (15)	-	-	46.7	56	-	-	60	78	-	-	-	-	-	-	-	-	-	-	40	33	-	-
Gangwha (12)	33.3	28	-	-	-	-	41.7	143	50	84	50	45	-	-	-	-	-	-	-	-	-	-
Pocheon (10)	-	-	-	-	20	17	-	-	60	190	-	-	-	-	-	-	-	-	50	53	-	-
Suwon (14)	42.8	33	50	45	-	-	57.1	87	64.3	176	57.1	56	-	-	-	-	-	-	-	-	-	-
Total (218)	11.5		22.9		3.2		46.3		39.4		26.6		6.0		3.2		2.3		18.8		1.8	

Where, [y] Province; [z] number of fields surveyed; RF= Relative frequency of occurrence (percentage of fields in which species was found); MD= Mean density of nematodes in 300 ㎤ soil; C. mor. = *Criconemoides morgensis*; D. des. = *Ditylenchus destructor*; H. dih. = *Helicotylenchus dihystera*; M. inc. = *Meloidogyne incognita*; M. hap. = *Meloidogyne hapla*; P. lep. = *Paratylenchus lepidus*; P. pen. = *Pratylenchus penetrans*; P. hil. = *Psilenchus hilarulus*; T. cla. = *Tylenchorhynchus claytoni*; T. sim. = *Trichodorus similis*; X. ame. = *Xiphinema americanum*.

and reddish brown lesions were also seen on severely stunted, off colored and poorly grown plants.

Some species of nematode identified in this survey are of economical importance and considered as serious pests of ginseng. These nematodes include *M. incognita, M. hapla, D. destructor* and *P. penetrans*. *Meloidogyne* spp. are sedentary endoparasites of roots and induce root galls. *D. destructor* attacks tubers and rhizomes, stem-like underground parts, causing the formation of necrosis. *P. penetrans* is a migratory endoparasite of roots, its infection make fine reddish-brown lesions on rootlets. It was reported that *M. hapla* and *P. penetrans* have been frequently associated with ginseng in USA and are causing substantial damage in ginseng production (Anonymous, 1999). Threshold levels at which a control practice for both species of nematodes should be conducted have been suggested. If root lesion nematode populations exceed 100 per 100 cc of soil, when sampled in late summer, soil fumigation prior to

planting should be treated. For root-knot nematodes, the population threshold is only 1 per 100 cc of soil. *D. destructor* causing new root rot disease of ginseng (Ohh *et al.*, 1983), infected roots exhibit small-discolored spots. In heavy attacks, the epidermis becomes grayish-black, abnormally thin, dry and cracked; underlying tissues are spongy and brownish, forming lumpy masses. All of these nematodes are potential pathogens to ginseng and their identification in ginseng fields or in the land planted to be used for ginseng cultivation should be cause of concern (Anonymous, 1999). Of the greater concern is the fact that these nematodes were encountered in soil samples from all provinces surveyed, and often occurring concomitantly. Since ginseng stays in the ground for at least 4 years, that may enable nematodes to increase their population above threshold levels; therefore, recommended management strategies should be taken by growers to prevent infestation of nematodes. Other nematodes species identified in this survey are ectoparasitic to root and so far have not been documented as dangerous pests of ginseng. However, frequent occurrence of *P. lepidus, T. claytoni, C. morgensis, H. dihystera*, and *P. hilarulus* in ginseng fields indicating that they may have pathogenic relation with ginseng. Therefore, further research is needed to determine their impact on ginseng. Species of *Xiphinema* and *Trichodorus* in addition to the direct root damage caused by their feeding also are known to transmit viral diseases (Brown *et al.*, 1995). As virus vectors they can be damaging to ginseng at very low population levels. The variation in occurrence frequency and density of each species of plant-parasitic nematodes in surveyed ginseng fields seems to be influenced by cropping pattern and cultural practices. Because plant-parasitic nematodes in cultivated soil may be affected by the planting of cover crops, the use of crop rotation, and fallow (Brodie *et al.*, 1970; Brodie & Murphy, 1975).

The results of this study indicate that plant-parasitic nematodes are widely distributed in ginseng fields of Korea. This survey provides important basic information for planning and administering nematode management strategies in ginseng fields of Korea. However, further research is needed to determine the significance of these nematodes on ginseng and to determine their possible interaction with other soil pathogens and the environment.

LITERATURE CITED

Anonymous (1999) Crop profile for Ginseng in Washington, USA. http://cipm.ncsu.edu/cropprofiles/docs/waginseng.html, updated 01 January, 1999.

Brodie BB, Murphy WS (1975) Population dynamics of plant nematodes as affected by combinations of fallow and cropping sequence. J. Nematol. 7:91-92.

Brodie BB, Good JM, Jaworski CA (1970) Population dynamics of plant nematodes in cultivated soil: Effect of summer crops in old agricultural land. J. Nematol. 2:147-151.

Brown DJF, Robertson WM, Trudgil DL (1995) Transmission of virus by plant nematodes. Ann. Rev. Phytopathol. 33:223-249.

Choi YE (2001) Nematoda (Tylenchida, Aphelenchida). Economic Insects of Korea 20. Ins. Koreana Suppl. 27: 392.

Choi YE, Park SD (1991) Nematodes associated with medicinal herbs and their control. Res. Rep., RDA Suwon, Rep. Korea 33:61-68.

Eisenback JD (1985) Diagnostic characters useful in the identification of the four most common species of root-knot nematodes (*Meloidogyne* spp.). In: An Advanced Treatise on *Meloidogyne*. Vol. I, Biology and control (Sasser, JN, Carter CC, Ed). 95-112. North Carolina State University Graphics, Raleigh, N.C., U.S.A.

Esser RP (1973) A diagnostic compendium of the genus *Xiphinema* Cobb, 1913. Proc. Soil and Crop Sci. Soc. Florida 33:88-92.

Handoo Z (2000) A key and diagnostic compendium to the species of the genus *Tylenchorhynchus* Cobb, 1913 (Nematoda: Belonolaimidae). J. Nematol. 32:20-34.

Handoo Z, Golden AM (1989) A key and diagnostic compendium of the genus. *Pratylenchus* Filipjev, 1936 (lesion nematode). J. Nematol. 21:202-218.

Jenkins WR (1964) A rapid centrifugal-flotation technique for separating nematodes from soil. Plant Dis. Rep. 48:692.

Kim JI, Choi DR, Han SC, Park JS (1987). Survey of plant parasitic nematodes in fields growing ornamental plants and medicinal herbs. Res. Rep., RDA, Suwon, Rep. Korea 29:124-129.

Ministry of Agriculture and Forestry, Korea (2002) Crop statistics.

Ohh SH, Lee SK, Lee JH, Han SC (1983) New root rot disease of *Panax ginseng* due to *Ditylenchus destructor* Thorne. Korean J. plant Pro. 22:181-185.

Park SD, Park SD, Choi BS (1993) Fauna of plant parasitic nematodes in medicinal herbs. J. Agric. Sci., RDA, Suwon, Rep. Korea 35:413-430.

Park SD, Khan Z, Choi YE, Choi BS (1998a) Association and distribution of plant-parasitic nematodes in peony (*Paeonia lactiflora* Pall) fields of Korea. Int. J. Nematol. 8:57-60.

Park SD, Khan Z, Kim SJ, Kim KJ, Min KK (1998b) Occurrence and distribution of plant parasitic nematodes in yam (*Discorea batatas*) fields in Korea. Int. J. Nematol. 8: 141-144.

Seinhorst JW (1959) A rapid method for the transfer of nematodes from fixative to anhydrous glycerin. Nematologica 4:67-69

Sikora RR, Carter WW (1987) Nematode interactions with fungal and bacterial plant pathogen-fact or fantasy. In: Vistas on Nematology. (Veech JA, Dikson DW Ed). 307-312. Soc. Nematol. Inc., Hyattsville, Maryland, USA.

Taylore DP, Netscher C (1974) An improved technique for preparing perineal patterns of *Meloidogyne* spp. Nematologica 20:268-269.

Zuckerman BM, Esnard J (1994) Biological control of plant nematodes-current status and hypothesis. Japanese J. Nematol. 24:1-13.