PLANT-PARASITIC NEMATODES ASSOCIATED WITH CROPS IN IDAHO AND EASTERN OREGON

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ABSTRACT

Hafez, S. L., A. M. Golden, F. Rashid, and Z. Handoo. 1992. Plant-parasitic nematodes associated with crops in Idaho and Eastern Oregon. Nematropica 22:193–204.

This is the first detailed report on plant-parasitic nematodes occurring in Idaho and eastern Oregon, U.S.A. Plant-parasitic nematodes from 186 soil samples collected in 26 counties were identified. Twenty-five nematode genera were found. Forty-seven species including two evidently undescribed are reported in the region for the first time. The new records are in 11 genera: *Criconemella, Geocenamus, Gracilacus, Hemicycliophora, Helicotylenchus, Merlinius, Paratylenchus, Pratylenchus, Trophonema, Trophurus,* and *Tylenchorhynchus.* Other nematode genera found were *Anomyctus, Aphelenchoides, Aphelenchus, Coslenchus, Ditylenchus, Heterodera, Hoplolaimus, Megadorus, Meloidogyne, Paratrichodorus, Psilenchus, Trichodorus, Tylenchus,* and *Xiphinema.*

Key words: geographical distribution, Idaho, Oregon, plant-parasitic nematodes, survey.

RESUMEN

Hafez, S. L., A. M. Golden, F. Rashid y Z. Handoo. 1992. Nematodos fitoparásitos asociados con los cultivos de Idaho y la parte oriental del estado de Oregon. Nematrópica 22:193–204.

Se presenta el primer informe detallado sobre la presencia de nematodos fitoparásitos en Idaho y la parte oriental del estado de Oregon, en los EE.UU. Se identificaron nematodos fitoparásitos de 186 muestras de suelo procedentes de 26 condados. Se encontraron 25 géneros de nematodos. Se registra por la primaera vez un total de 47 especies, que incluyen a dos especies que no han sido descritas. Los 11 géneros que presentan nuevos registros son: *Criconemella, Geocenamus, Gracilacus, Hemicycliophora, Helicotylenchus, Merlinius, Paratylenchus, Pratylenchus, Trophonema, Trophurus,* y *Tylenchorhynchus.* Otros géneros de nematodos encontrados fueron *Anomyctus, Aphelenchoides, Aphelenchus, Coslenchus, Ditylenchus, Heterodera, Hoplolaimus, Megadorus, Meloidogyne, Paratrichodorus, Psilenchus, Trichodorus, Tylenchus,* y *Xiphinema.*

Palabras clave: distribución geográfica, Idaho, nematodos fitoparásitos, Oregon, prospección.

INTRODUCTION

Idaho lies entirely on the western watershed of the Rocky Mountains and, excepting a small area in the southwest, is drained by the Snake River and its branches. Much of Idaho is mountainous. Farming occurs in mountain valleys, on rolling prairies, and on the large Snake River Plain. Elevation ranges from 240 m to 3 860 m. Most farms are located between 670 and 1 829 m above sea level. Thirty-three percent of the annual precipitation occurs during the winter months, and accumulates as a source of irrigation water. The average length of the growing or frost-free season ranges from less than 70 days to more than 160 days.

Agriculture is the primary industry in Idaho. In the north there are vast dryland grain, pea, and hay fields. The southwest has corn, potatoes, grain, sugarbeets, and alfalfa seed or hay, mixed with fruit orchards, vegetables, and specialized commodities such as mint, hops, and seed crops. Eastward along the Snake River are large irrigated fields of corn, alfalfa hay, dry beans, potatoes, small grains, and sugarbeets. In the southeast, a mixture of dryland and irrigated grain, hay, and potato are grown. Idaho traditionally leads the United States in potato production, is

ranked second in sugarbeets, third for barley, mint, hops, prunes, and plums, and fourth in summer storage onion production.

During 1986-1989, approximately 15 000 soil samples from Idaho and eastern Oregon were submitted to the diagnostic clinic of the University of Idaho at Parma for nematode assay. Of these, 186 representative samples were selected for identification to species level, with the objective of identifying species that may have a significant impact on agriculture in the region. This is the first extensive report on plant-parasitic species known to be associated with several crops in this region; a few earlier reports of nematodes in the region dealt primarily with individual species (8,17,22,24).

MATERIALS AND METHODS

Soil samples were collected by using a standard 2.5-cm-diam soil probe, 50 cm deep. Each soil sample was mixed thoroughly and a 500-cm^3 subsample was processed by the wet sieve centrifugation technique and sugar flotation process (2). Extracted nematodes were counted by using a Hawksley counting slide and identified to genus. After counting the nematodes, specimens of each genus were fixed in hot 5% formaldehyde solution, processed to anhydrous glycerine by the modified Seinhorst method (25) and mounted on Cobb slides with double cover slips (3). The nematodes were examined with a compound microscope and identified with recent toxonomic keys (4,5,6,7,16,19,20,21,23,26). Identification was made by Dr. A. M. Golden. Specimens of nematodes reported here for the first time in Idaho and eastern Oregon are deposited in the USDA Nematode Collection at Beltsville, Maryland.

RESULTS AND DISCUSSION

The 186 soil samples yielded 25 different nematode genera (Table 1). A total of 53 species, including two undescribed forms, were identified; 47 of these represent new occurrences for the region while six were reported earlier. In addition, 17 other forms in several genera were identified only to genus due generally to insufficient specimens for accurate species identity. Most samples contained more than one species, and often more than one genus. Ninety-two percent of the soil samples contained *Pratylenchus* spp., 38% contained *Merlinius*, and 30.6% contained *Paratylenchus* spp. Also frequently encountered were *Helicotylenchus* spp. (22%), *Tylenchorhynchus* spp. (22%), *Ditylenchus* spp. (10%), *Meloidogyne* spp. (18%), and *Criconemella* spp. (9%). Less frequently encountered were *Xiphinema* spp. (8%), *Paratrichodorus* spp. (4%), *Hemicycliophora* spp. (4%), and *Heterodera* spp. (6%). Each of the remaining eight genera of plant-parasitic nematodes were recovered in less than 3% of the 186 samples. Three of these genera (*Geocenamus, Trophurus,* and *Trophonema*) were recorded for the first time in the region. These other five genera have not yet been demonstrated to contain pathogenic species: *Anomyctus, Aphelenchus, Coslenchus, Megadorus,* and *Tylenchus.*

Pratylenchus neglectus, the most common species, was widely distributed and was encountered in 56% of the 186 samples. The only *Merlinius* species found were *M. brevidens* and *M. grandis*. Nine species of *Tylenchorhynchus* were identified. *Paratylenchus* was represented by four species with *P. projectus* encountered most frequently (14% of all samples). *Criconemella curvata* was the most frequently found species of *Criconemella*. Four species of *Hemicycliophora* were iden-

Table 1. Plant nematodes from Idaho and eastern Oregon.

Nematode genus and species	Association																Incidence (% of all soil samples)
	Alfalfa (*Medicago sativa*)	Apple (*Malus* sp.)	Barley (*Hordeum vulgare*)	Bean (*Phaseolus* sp.)	Bluegrass (*Poa* sp.)	Corn (*Zea mays*)	Clover (*Trifolium* sp.)	Hop (*Humulus lupulus*)	Mint (*Mentha* sp.)	Onion (*Allium cepa*)	Pasture[y]	Pea (*Pisum sativum*)	Peppermint (*Mentha piperita*)	Potato (*Solanum tuberosum*)	Spearmint (*Mentha spicata*)	Sugarbeet (*Beta vulgaris*)	Turnip (*Brassica rapa*)	Wheat (*Triticum aestivum*)	
Anomyctus xenurus Allen, 1940		1[z]																	0.5
Aphelenchus sp.	1			1												2			2.1
Aphelenchoides sp.	1		1											1					2.1
Coslenchus sp.	1													3				1	3.2
Criconemella sp.																		2	1.0
Criconemella curvata (Raski, 1952) Luc & Raski, 1981	1	2					1						1	1				1	4.8
C. ornata (Raski, 1958) Luc & Raski, 1981		1			1										1				1.6
C. rustica (Micoletzky, 1915) Luc & Raski, 1981														1					0.5
Ditylenchus sp.	1	1	2			1				1				2		1		4	8.6
Ditylenchus destructor Thorne, 1945														1					0.5
D. dipsaci (Kühn, 1857) Filipjèv, 1936	1									1									1.0
Geocenamus tenuidens Thorne & Malek, 1968														1					0.5
Gracilacus sp.																1			0.5
Hemicycliophora sp.			1		1													1	1.6
Hemicycliophora californica Brzeski, 1974		1																	0.5

(Continued.)

Table 1. Continued.

Nematode genus and species	Association																Incidence (% of all soil samples)
	Alfalfa (*Medicago sativa*)	Apple (*Malus* sp.)	Barley (*Hordeum vulgare*)	Bean (*Phaseolus* sp.)	Bluegrass (*Poa* sp.)	Corn (*Zea mays*)	Clover (*Trifolium* sp.)	Hop (*Humulus lupulus*)	Mint (*Mentha* sp.)	Onion (*Allium cepa*)	Pasture[y]	Pea (*Pisum sativum*)	Peppermint (*Mentha piperita*)	Potato (*Solanum tuberosum*)	Spearmint (*Mentha spicata*)	Sugarbeet (*Beta vulgaris*)	Turnip (*Brassica rapa*)	Wheat (*Triticum aestivum*)	
H. obtusa Thorne, 1955														1					0.5
H. thienemanni (Schneider, 1925) Loos, 1948		1												1					1.0
H. vidua Raski, 1958																		1	0.5
Helicotylenchus sp.														1				1	1.0
Helicotylenchus n. sp. (evidently undescribed)						1							1						1.0
Helicotylenchus bradys Thorne & Malek, 1968																1			2.6
H. crenacauda Sher, 1966																1			0.5
H. digonicus Perry in Perry, Darling & Thorne, 1959		1			1	2					1			1				7	12.3
H. dihystera (Cobb, 1983) Sher, 1961										1								1	1.0
H. minzi Sher, 1966																		1	0.5
H. platyurus Perry in Perry, Darling & Thorne, 1959														1					0.5
H. pseudorobustus (Steiner, 1914) Golden, 1956						2										1		1	2.6
Heterodera avenae Wollenweber, 1924																		5	3.2

H. humuli Filipjèv, 1934							1													0.5
H. schachtii A. Schmidt, 1871																1		1		1.0
H. trifolii Goffart, 1932	1												1					1		1.6
Hoplolaimus sp.																		1		0.5
Megadorus megadorus (Allen, 1941) J. B. Goodey, 1960																		2		0.5
Meloidogyne spp. (only juveniles from soil)	3	1		1		1				3		1	7					8		18.0
Merlinius brevidens (Allen, 1955) Siddiqi, 1970	3	1	1	1		3				4		1	7			4	1	19		38.0
M. grandis (Allen, 1955) Siddiqi, 1970										1										0.5
Paratrichodorus sp.			2															1		1.6
Paratrichodorus minor (Colbran, 1956) Siddiqi, 1974			1													1		1		1.6
P. porosus (Allen, 1957) Siddiqi, 1974													1							0.5
Paratylenchus sp.				1		1				2			1			1		1		4.3
Paratylenchus bukowinenis Micoletzky, 1922													1							0.5
P. projectus Jenkins, 1956	1	1	1		1			1	1		1	1	5	1		2		2		14.0
P. tateae Wu & Townshend, 1973	1	1			1													2		3.2
P. tenuicaudatus Wu, 1961								1				1		1				1		8.6
Pratylenchus sp.		1											1					1		2.1
Pratylenchus coffeae (Zimmermann, 1898) Filipjèv & Schuurmans Stekhoven, 1941														1				1		7.5
P. crenatus Loof, 1960		1			1															1.6
P. neglectus (Rensch, 1924) Filipjèv & Schuurmans Stekhoven, 1941	8	1	4	1	2	4	1	1		4	1	2	14			3	1	21		56.0

(Continued.)

Table 1. Continued.

Nematode genus and species	Association														Incidence (% of all soil samples)
	Alfalfa (*Medicago sativa*)	Apple (*Malus* sp.)	Barley (*Hordeum vulgare*)	Bean (*Phaseolus* sp.)	Bluegrass (*Poa* sp.)	Corn (*Zea mays*)	Clover (*Trifolium* sp.)	Hop (*Humulus lupulus*)	Mint (*Mentha* sp.)	Onion (*Allium cepa*)	Pasture[y]	Pea (*Pisum sativum*)	Peppermint (*Mentha piperita*)	Potato (*Solanum tuberosum*)	Spearmint (*Mentha spicata*)	Sugarbeet (*Beta vulgaris*)	Turnip (*Brassica rapa*)	Wheat (*Triticum aestivum*)	
P. penetrans (Cobb, 1917) Filipjèv & Schuurmans Stekhoven, 1941						1								2				2	3.2
P. scribneri Steiner, 1943						1												3	2.1
P. thornei Sher & Allen, 1953	1		1			2		1		1				3		3		13	19.8
P. vulnus Allen & Jensen, 1951		1																	0.5
Psilenchus sp.										1								1	1.0
Trichodorus sp.													1						0.5
Trophonema arenarium (Raski, 1956) Raski, 1957		1																	1.0
Trophurus minnesotensis (Caveness, 1958) Caveness, 1959																		1	0.5
Tylenchus sp.	2	1	1	1										2		1		3	5.9
Tylenchorhynchus acutus Allen, 1955	2	1	2			1		1								2		2	5.9
T. acutoides Thorne & Malek, 1968														1					0.5
T. annulatus (Cassidy, 1930) Golden, 1971						1									1			1	1.6

T. capitatus Allen, 1955								1		1	1.0
T. clarus Allen, 1955	1						1	1		3	3.2
T. cylindricus Cobb, 1913										1	0.5
T. huesingi Paetzold, 1958				1							0.5
T. maximus Allen, 1955		1		1		2		2		3	5.3
Tylenchorhynchus n. sp. (evidently undescribed)								1			0.5
Tylenchorhynchus sp.			1					1		2	2.1
Xiphinema sp. (juveniles only)	1	1			1	2			1	3	5.9
Xiphinema americanum Cobb, 1913		1									0.5
X. californicum Lamberti & Bleve-Zacheo, 1979		1									0.5
X. rivesi Dalmasso, 1969								1			0.5

[y]Pasture: mixture of grasses and legumes.
[z]Number of localities where detected for the crop association indicated.

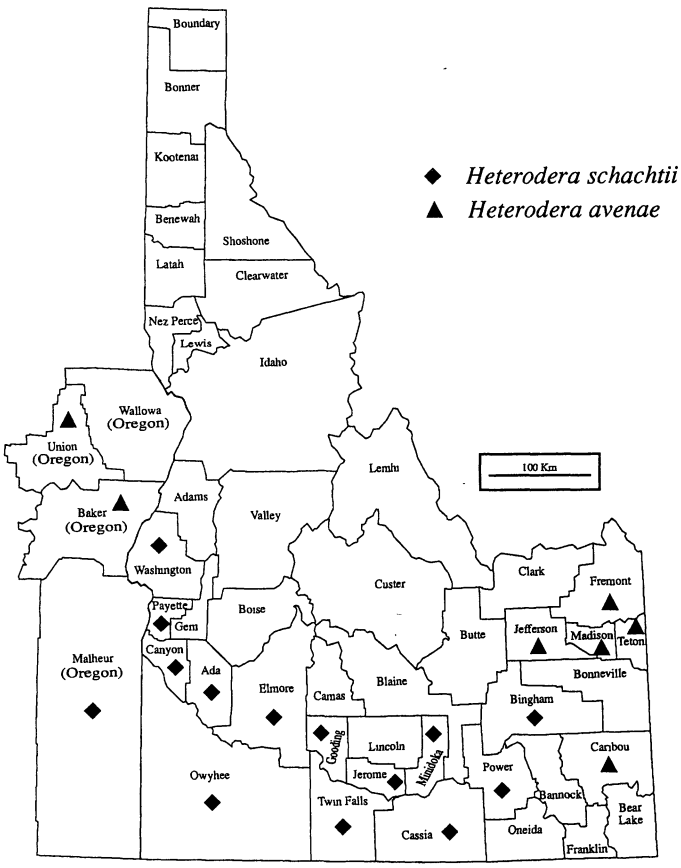

Fig. 1. Distribution map by county of *H. schachtii* and *H. avenae* in Idaho and eastern Oregon.

tified. *Helicotylenchus* was represented by seven identified species; *Helicotylenchus digonicus*, which occurred in 12.3% of the samples, was the most common. Juveniles of *Meloidogyne* spp. were found in samples from widely scattered localities and associated with nine different crops. None were identified to species level. Two species of *Ditylenchus* were found, *D. dipsaci* and *D. destructor*. Species of *Heterodera* included *H. schachtii, H. avenae, H. humuli,* and *H. trifolii*. Two species of *Paratrichodorus, P. minor,* and *P. porosus*, were found. Species of *Xiphinema* identified were *X. americanum, X. californicum,* and *X. rivesi*.

The most important finding was the widespread occurrence of *Heterodera* spp. (Fig. 1), *Pratylenchus* spp. (Fig. 2), and *Meloidogyne* spp., *Ditylenchus* spp., and *Paratrichodorus* spp. (Fig. 3). Species in all five genera are known to damage or are potentially damaging to major crops grown in Idaho and eastern Oregon. Of particular concern would be damage to potato by *Meloidogyne hapla* and *M. chitwoodi* (1,12,17,24), *Pratylenchus coffeae* and *P. penetrans* (1,12,17), *Ditylenchus destructor* (1,11,28), and *Paratrichodorus* spp. or *Trichodorus* spp. The latter two species transmit tobacco rattle virus, causing corky ringspot, a serious disease of potato

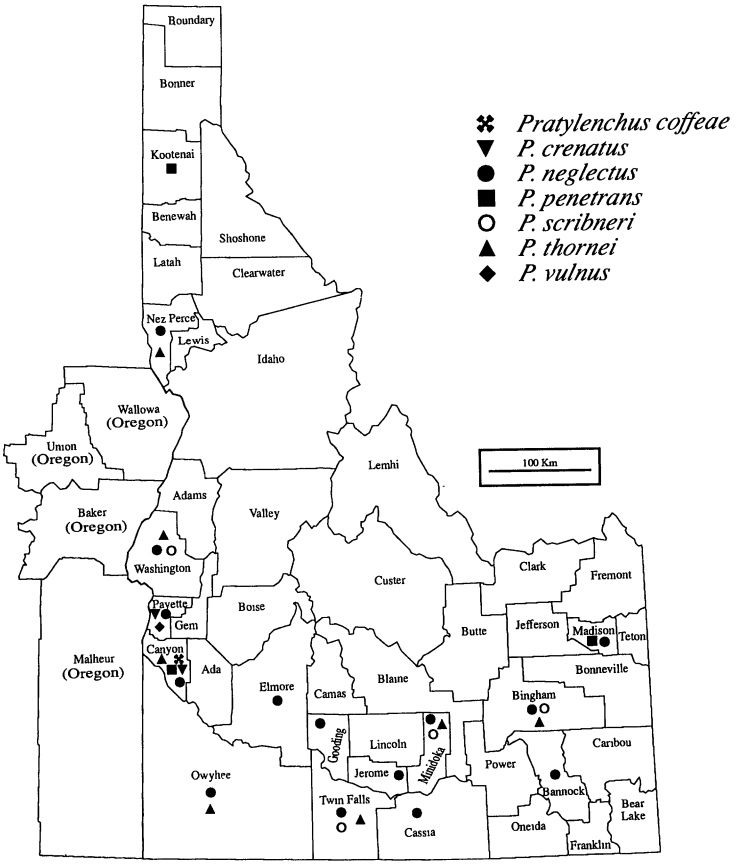

Fig. 2. Distribution map by county of seven different species of *Pratylenchus* in Idaho.

in limited areas of the Pacific Northwest (1,10). Other potentially damaging associations include *Ditylenchus dipsaci* on alfalfa (9,13) and onion (18), *H. avenae* on wheat (9,14,15), and *H. schachtii* on sugarbeet (27).

Root-knot nematodes (*Meloidogyne* spp.) are widely distributed, but are limited to specific areas by temperature and cropping practice (1). Potato is an important commodity of the Pacific Northwest. Root-knot nematodes occur throughout the commercial potato growing areas, and are presently serious pests in Idaho, Oregon, Washington, and California. Two species, known as the northern (*M. hapla*), and Columbia (*M. chitwoodi*) root-knot nematodes, occur in many commercial potato growing areas of Idaho and eastern Oregon. These nematodes mainly affect potato tuber quality, although economic damage also occurs as reduced yield (1,12,17,24).

Stubby root nematodes (*Paratrichodorus* spp. and *Trichodorus* spp.) are important parasites of potatoes, not so much for direct damage they cause but for the tobacco rattle virus they transmit to potatoes (10). At harvest, infected tubers may have deep cracks and shallow corky depressions on their surface, which renders them unmarketable. Corky

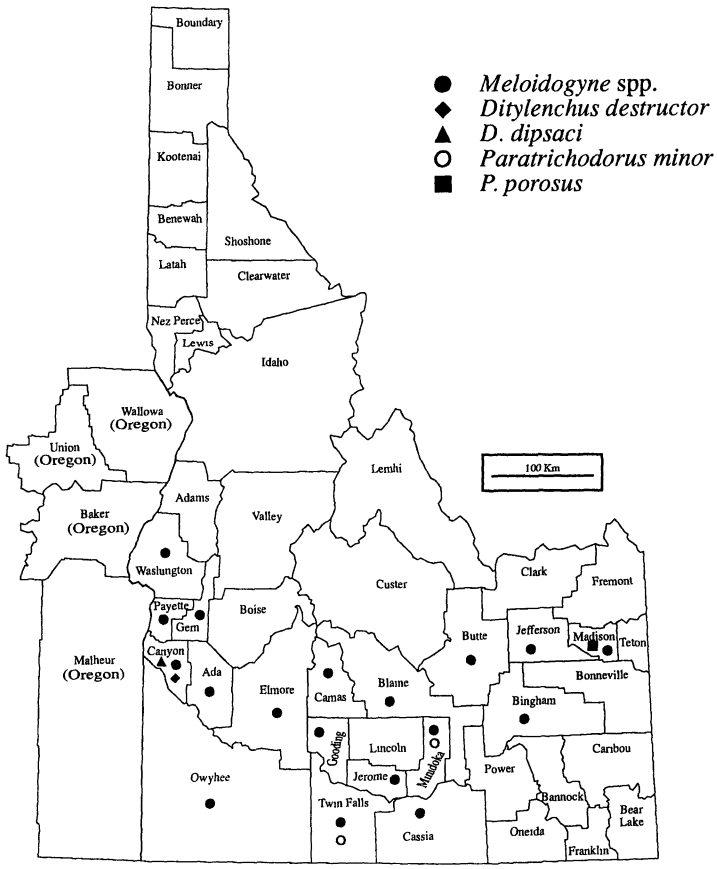

Fig. 3. Distribution map by county of *Meloidogyne* spp., *Ditylenchus destructor, D. dipsaci, Paratrichodorus minor,* and *P. porosus* in Idaho.

ringspot disease has worldwide geographical distribution that includes Europe, North and South America, and Japan (1,10).

Potato rot nematode (*D. destructor*) is an important pest of potatoes in temperate regions of Europe and is especially widespread in the former U.S.S.R. It also occurs in South Africa, some areas of the Mediterranean region, South America, and isolated areas of North America (1). This nematode is known to cause damage to potatoes only in a few isolated areas of Idaho (Fig. 2) (11). Potato rot nematodes damage tubers, causing a serious problem in stored potatoes. In recent years, losses in the United States and Canada have declined, the greatest losses occurring in the former U.S.S.R. In Estonia, 80–90% infestation of tubers is not uncommon and annual losses in the U.S.S.R. were estimated at 150 000 metric tons (1).

Root lesion nematodes (*Pratylenchus* spp.) are important and widespread. At least 15 species of *Pratylenchus* have been reported associated with potato culture (1). Temperature requirements vary with different species, causing different species to predominate in different cli-

mates. The most common root lesion nematode present in Idaho and eastern Oregon potato fields, *P neglectus*, causes little known damage. However, *P. coffeae* and *P. penetrans*, which have been found recently in a few areas, can cause severe yield and quality losses (12). *Pratylenchus penetrans* is most widespread and an important pest of potatoes in Europe and northern potato producing areas of the United States (1); this species is capable of causing a growth decline of 50–70% and a yield decline of 10–50%. *Pratylenchus coffeae* appears to be the dominant species attacking potatoes in Japan (1).

Stem nematode (*D. dipsaci*), is the most important nematode pathogen on alfalfa, and has accompanied alfalfa seed to practically every corner of the globe. The alfalfa stem nematode causes economic losses in alfalfa under certain growing conditions. It occurs in many alfalfa growing areas in Idaho, in older fields and where waste water or tail water is used for irrigation (13). Severe damage by this nematode is usually confined to the first cutting of alfalfa during cool, humid weather.

The sugarbeet cyst nematode (*Heterodera schachtii*) has been found in most beet growing areas within 17 states in the United States and in 40 countries of North and South America, Europe, Africa, and the Middle East, and has been reported in Australia, New Zealand, and Hawaii. The nematode caused severe losses in several beet growing areas in California, Utah, Colorado, Oregon, and Idaho (27). In Idaho and eastern Oregon the sugarbeet cyst nematode is one of the most serious and important limiting factors for sugarbeet production and a constant threat for the sugarbeet industry. In Idaho and eastern Oregon, more than 50% of the sugarbeet acreage is infested with this nematode at levels where control is needed to obtain economical yield. *Heterodera schachtii* has been found in beet growing areas within 13 counties in Idaho (Fig. 1).

The cereal cyst nematode (*H. avenae*) occurs in New Zealand, Peru, and the United States, throughout Europe and the Mediterranean basin, and in southeastern Canada. It damages wheat in Australia, Africa, Japan, Israel, and the former Soviet Union (9,14,15). In the United States, it has recently caused economic losses in the Pacific Northwest. The damage of this nematode has been seen on wheat in Idaho (Fig. 1) where yield was reduced more than 70% (15).

This report should aid future workers in determining what plant-parasitic nematodes are present and may be involved in plant disease problems in this region. Management of nematodes is an important aspect of successful agricultural plant production and development of effective management methods requires accurate identification of the genera and species of nematodes.

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