

## WSU Vegetable Pathology Team August 2005 Newsletter

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### GREETINGS!

Welcome to the August 2005 newsletter of the WSU Vegetable Pathology Team. We hope your season has been productive, and your harvests are healthy and bountiful! The focus of this newsletter is on nematode pests of vegetable crops.

### VEGETABLE EVENTS

#### Field days

The **WSU Vegetable Seed Field Day** was held at the WSU-NWREC in Mount Vernon on Thursday, 16<sup>th</sup> June from 3 – 6 pm. Weed control, disease management, and entomology field trials were demonstrated. For copies of the field day handouts contact Lindsey du Toit at [dutoit@wsu.edu](mailto:dutoit@wsu.edu) or 360-848-6140.



Fig. 1. Tim Miller, WSU Weed Scientist, presenting field trials on weed management in table beet & Swiss chard seed crops at the WSU Vegetable Seed Field Day on 16 June 2005.

**The Icebox Watermelon Field Day** will take place on **31<sup>st</sup> August 2005** from **2 - 4 pm** at the WSU Vancouver REU. For more information contact Carol Miles at [milesc@wsu.edu](mailto:milesc@wsu.edu) or (360) 576-6030.

**The WSU Onion Cultivar Field Day** will take place on **26<sup>th</sup> August 2005** from **9 am – noon** at L&L Farms near Connell, WA. Replicated plots of 49 cultivars will be on display, with research updates on neck rot and *iris yellow spot virus*. A BBQ will follow, at the Scootenev Reservoir Recreational Area. For more information contact Lindsey du Toit at [dutoit@wsu.edu](mailto:dutoit@wsu.edu) or (360) 848-6140, or Mark Trent at [trentm@wsu.edu](mailto:trentm@wsu.edu) or (509) 754-2011 ext. 413.

### Upcoming conferences

*31<sup>st</sup> International Carrot Conference* at the Sandman Hotel Montreal in Longueuil, Quebec, Canada on 11-14 September 2005. Visit the conference website at [www.cshs.ca/carrot/](http://www.cshs.ca/carrot/)

*Pacific Northwest Vegetable Association Annual Convention & Trade Show* at the Red Lion Hotel in Pasco, WA on 17-18 November 2004. Visit the PNVA website at <http://www.pnva.org/>

*31<sup>st</sup> Annual Washington Tilth Producers' Convention* on 11-13 November 2005 at the Wenatchee Convention Center in Wenatchee, WA. There will be a pre-conference symposium titled "Alternative Energy on the Farm" on Friday 11<sup>th</sup> November from 10 am – 5 pm, with keynote speaker Fred Provenza from Utah State University. View the Tilth website at <http://www.tilthproducers.org/conference.htm> or call Nancy Allen at (206) 442-7620.

## PLANT PARASITIC NEMATODES ON VEGETABLE CROPS IN WASHINGTON

Although many different plant parasitic nematodes occur on vegetables in Washington, some are more commonly encountered than others. Following is general information about important nematodes in the state, and some of the vegetables they affect. For details on management recommendations of specific nematodes in particular vegetable crops, refer to the latest edition of the *PNW Disease Management Handbook* and other appropriate resources (refer to **Resources on Plant Parasitic Nematodes & Their Management** below) or contact your local WSU Extension office.

**Cyst nematodes:** Cyst nematodes are sedentary parasites and belong to the genus *Heterodera*. Sedentary parasite means that once the nematode feeds on the root, it does not move. *H. goettingiana* parasitizes roots of pea, faba bean and vetch. *H. schachtii* has a much wider host range, and can parasitize cabbage, beet, cauliflower, Brussels sprouts, broccoli, turnip, rutabaga and radish, and weedy hosts like dock, knotweed, lambsquarters, mustard, nightshade, purslane, and red root. The "cysts" are the dead bodies of the female, and contain eggs. Examination of roots with a hand lens will reveal the small, bead-like cysts. Cysts are white when young and embedded in the roots, but turn brown with age and slough-off as the root decomposes (**Fig. 2**).



Fig. 2. Symptoms (left) & signs (cysts, right) of the pea cyst nematode, *Heterodera goettingiana* (Photos courtesy of Debra Inglis).

General field symptoms of cyst nematode damage occur as patches of stunted, chlorotic plants. The patches are at first small and circular, but later may extend to large areas. When plants die, the patches can become quite weedy. Depending on soil type, expansion of the patches may take years because nematodes, on their own, move limited distances in soil. However, movement of cysts via farm equipment and other means can result in initiation of infested areas relatively quickly.

Specific symptoms on infected green pea plants are small pointed leaves that turn bright yellow at flowering, with yellowing progressing rapidly from the base to the top of the plant. The root systems develop poorly, and there are few nitrogen-fixing nodules or secondary roots. Remaining infected roots tend to branch perpendicularly from the tap root. Symptoms on infected cabbage and related plants are similar to green pea, but infected crucifers frequently have a dense system of secondary roots called hairy-root.

Cyst nematodes overwinter in soil as eggs encased in the brown cysts. When temperature and moisture conditions are favorable in the spring, juvenile nematodes hatch from the eggs. Host root exudates are generally needed to induce hatching. Once juvenile nematodes penetrate roots, they feed on root cells and molt. Eventually, adult females form, each with ~100+ eggs. More than one cycle of egg hatching, root invasion and cyst development can occur per growing season, depending on the nematode, host and environmental conditions. Mature cysts can survive in soil 10+ years, and are spread primarily by infested soil adhering to equipment, plant materials, or by water movement.

Since cyst nematodes can survive for long periods of time without a host and still cause severe damage when infested soils are planted to a susceptible crop, control can be

difficult and eradication is unlikely. Preventive approaches which limit establishment in pea fields and minimize build-up of soil populations are critical to management. Fumigation and crop rotation are generally advised.

Care should be taken to plant susceptible crops only if soil populations of cyst nematodes are low. To determine readily whether cysts are present, a teaspoonful of soil can be stirred in a glass of water. The debris will float to the surface, and the glass can be examined for brown cysts adhering to the sides. This test will not predict the severity of infestation, and negative results do not necessarily mean the field is free of cyst nematodes. More sophisticated extraction techniques are available to determine actual cyst and egg populations in soil, and are available through labs that offer nematode testing services (see **Nematode Testing** below). Economic thresholds have been established for most cyst nematodes, and give growers an indication of whether or not they may plant a susceptible crop.

**Lesion nematodes:** Root lesion nematodes (*Pratylenchus* spp.) are migratory endoparasites, meaning that they continuously move in-and-out of soil and from feeding site-to- feeding site. This type of feeding activity results not only in the formation of lesions, but also wounds on the roots, and gives secondary micro-organisms multiple opportunities to infect root tissues. As a result, plants may be affected by *Pratylenchus penetrans* alone or in synergism with other plant pathogens e.g. *Verticillium*, *Erwinia*, *Fusarium* and *Pythium* spp. One well-known synergistic disease is early dying on potato caused by *Pratylenchus* plus *Verticillium*.

Several species of the root lesion nematode have been reported to infect vegetable crops. *Pratylenchus penetrans* is one that can cause serious economic losses. Onions, potatoes, carrots, and green peas have shown damage as a result of high nematode populations in some locations in Washington. Root lesion nematode damage often occurs in defined spots in fields. Symptoms on above-ground plant parts include chlorosis, stunting, and a general lack of vigor. Below-ground symptoms appear as brown lesions on the roots; these can occur on the taproot, although secondary or tertiary feeder roots are usually the nematode's preferred



Fig. 3. Severe damage to pea roots caused by the lesion nematode, *Pratylenchus penetrans* (photo courtesy of Katerina Riga).

feeding sites (**Fig. 3**).

The root lesion nematode disease cycle is relatively simple, and proceeds from the egg through four molts of juvenile stages to the adult egg-laying female. All juvenile and adult stages of *P. penetrans* can invade roots. *P. penetrans* can be found as deep as 60 cm in the soil profile. Penetration of roots occurs behind the zone of elongation, and affected root tissue may darken as a result of oxidation of phenolic compounds. The lesion nematode is disseminated by transportation of root debris or soil, or by water. Economic thresholds vary from crop to crop. However, only one *P. penetrans* nematode per gram of soil is sufficient to cause moderate damage to most vegetable roots.

Control is achieved primarily with nematicides, if they are registered for the particular vegetable crop. If lesion nematode numbers are high before planting, fumigation may be recommended depending on the value of the crop. Alternatively, a nematicide like Vydate can be applied after planting, if it is registered for the specific vegetable crop. In some instances, crop rotation may provide control, but its efficiency is dependent upon the host range of a particular *Pratylenchus* species and the availability of economic crop alternatives. Although the lesion nematode is a rather cosmopolitan nematode, which makes crop rotations difficult to arrange, field crops like forage pearl millet have shown great potential in controlling the lesion nematode. Green manures (i.e., some mustard varieties, French marigolds, winter and summer Swede rape) and soil amendments (e.g., neem cake, mustard meals) can contribute to nematode control.

**Root knot nematodes:** The root knot nematode attacks many vegetable crops. In Washington, there are two species, the northern (*Meloidogyne hapla*) and Columbia (*M. chitwoodi*). Northern root knot nematodes are very damaging to carrot; the Northern and Columbia are among the most important problems in potato production; and the Northern root knot affects tomato. Root knot nematodes are sedentary endoparasites, i.e., they tunnel into roots and establish permanent feeding sites from which they do not move.

Infected carrots are typically forked and malformed. Numerous knots can be found on the tap root and secondary roots of plants in affected crops (**Fig. 4**). Infections on potato rarely cause aboveground plant symptoms, but distinctive pimple-like bumps and lumps are quite evident on the tubers. Tiny brown spots can also be detected within the potato tuber vascular ring, and become most prominent once the female begins egg production (**Fig. 5**). The female's white body and associated egg sac (outside of the body) can sometimes be seen with a hand lens directed towards the center of the brown spot.



Fig. 4. Damage to a coriander seed crop by the root knot nematode, *Meloidogyne* sp. (Photos courtesy of Gary Pelter and Lindsey du Toit).

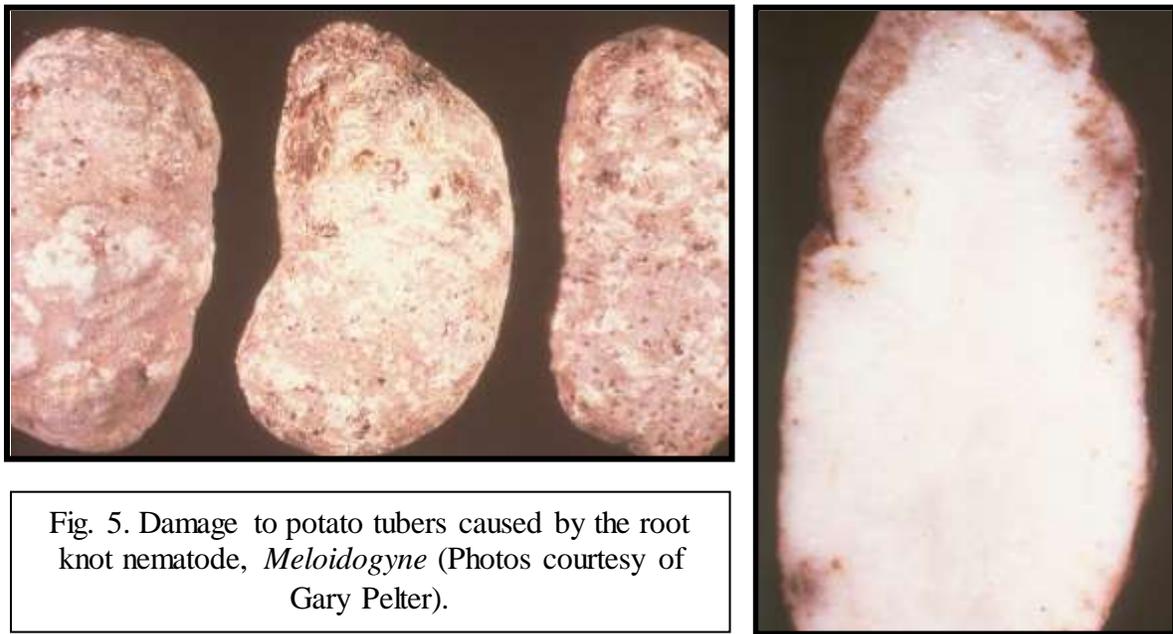


Fig. 5. Damage to potato tubers caused by the root knot nematode, *Meloidogyne* (Photos courtesy of Gary Pelter).

Rotation with a nonhost crop such as corn or cereal grains can be helpful. Not irrigating from ponds containing water drained from infested fields is also recommended. Marigold plantings (especially in home gardens) may suppress soil populations. Soil fumigants and nematicides are registered against root knot in Washington, and are advised when economic damage thresholds are reached. Soils should be sampled in late summer or early fall when nematode populations are highest. Less than one root knot nematode in 250 cc soil can cause severe economic losses. Control strategies may depend on the species of root knot nematode, so species identification should be requested when samples are submitted to a nematology laboratory. Use of certified planting stock, sanitation of field equipment, control of weeds that are susceptible hosts, and use of green manure crops like sudangrass and rapeseed are also recommended measures against root knot on potato. For tomato, resistant cultivars are available.

**Stubby root nematodes:** Found primarily on onion and potato in Washington, *Paratrichodorus* and *Trichodorus* spp. are ectoparasites since they feed from outside roots and move from cell-to-cell without entering the root tissues.

Feeding by *Trichodorus* or *Paratrichorus* spp. may induce proliferation of short, stubby lateral roots and excessive upper roots, hence the name of these nematodes. The roots become darker in color. Some species may cause root swelling and galling. Some species of *Paratrichodorus* produce salivary secretions that are extremely toxic to plants, resulting in more severe injury to plants than expected from relatively small populations parasitizing the roots. Heavily damaged plants may be stunted severely, chlorotic, and wilted, producing lower yields as a result of limited feeder roots. However, these nematodes rarely kill plants. Symptomatic onions have short discolored roots, with dark stubby tips. Damage on onions can be severe, and control is usually recommended (**Fig. 6**). Although potato plants are not directly impacted by these nematodes, some species vector the *Tobacco rattle virus* (TRV) which causes corky ringspot on potato tubers, a disease of serious economic consequence.

Stubby root nematodes are most common in sandy or sandy loam soils, often fairly deep in the soil (up to 60 cm). They are more sensitive to desiccation than other plant parasitic nematodes, but can survive low soil moisture if the soil dries slowly. The life cycle of *Trichodorus* and *Paratrichodorus* spp. is about 20 to 45 days from egg to egg, depending on the species as well as environmental conditions and susceptibility of the crop.

Cultural control practices in onion crops include not planting onions after mint. Soil sampling to determine population levels, followed by soil fumigation or application of nematicides, are the main methods of control of this nematode on potato.



Fig. 6. Stunting & root damage in an onion crop caused by the stubby root nematode, *Paratrichodorus* (Photos courtesy of Lindsey du Toit).

#### Selected nematode references:

1. Abbasi, P.A, Riga, E., Coon, K.L., & Lazarovits, G. 2005. Toxicity and disease suppressive effects of Neem cake soil amendment against plant parasitic nematodes and soilborne plant pathogens. *Canadian J. Plant Pathology* 27:38-45.
2. Ball-Coelho, A.J., Bruin, R.C., Roy & Riga, E. 2003. Forage millet and marigold rotation crops for biological control of *Pratylenchus penetrans* in potato. *Agronomy Journal* 95:282-292.
3. Dolliver, J. S. 1961. Population levels of *Pratylenchus penetrans* as influenced by treatments affecting dry weight of Wando pea plants. *Phytopathology* 51:364-367.
4. Ingham, R.E., Merrifield, K.S., Hamm, P.B., & Riga, E. 2005. First report of stunting and root rot of potato associated with *Pratylenchus penetrans* in the Columbia Basin of Washington. *Plant Disease* 89:207.
5. Jensen, H. J. 1972. Nematode pests of vegetable and related crops. Pages 377-409 in: *Economic Nematology*, J. M. Webster, ed. Academic Press, New York.

6. Mai, W.F., Bloom, J.R., and Chen, T.A. 1977. Biology and ecology of the plant parasitic nematode *Pratylenchus penetrans*, Penn. State Univ. Coll. Agric. Agric. Exp. Stn. Bull. 815.
7. Oyekan, P.O.C., Blake, C.D., and Mitchell, J.E. 1972. Histopathology of pea roots axenically infected by *Pratylenchus penetrans*. J. Nematol. 4:32-35.
8. Potter, J.W., & Olthof, T.H.A. 1993. Nematode pests of vegetable crops, Pp. 171-207 in: Plant Parasitic Nematodes in Temperate Agriculture. CAB International, Cambridge, UK.
9. Pscheidt, J. and Ocamb. C. 2005. 2005 Pacific Northwest Plant Disease Management Handbook. Oregon State University, Washington State University, and University of Idaho.
10. Sherf, A.F. and Macnab, A.A. 1986. Vegetable Diseases and Their Control. 2<sup>nd</sup> Edition. John Wiley & Sons, New York, NY.
11. Shurtleff, M.C., and Averre, C.W. III. 2000. Diagnosing Plant Diseases Caused by Nematodes. APS Press, St. Paul, MN.
12. Riga, E., Potter, J., & Hooper, C. 2005. *In vitro* effect of marigold exudates on plant parasitic nematodes. Phytoprotection 86: *In Press*.
13. Tedford, E.C. and Inglis, D.A. 1999. Evaluation of important legumes in the Pacific Northwest as hosts for the pea cyst nematode. J. Nematol. 31:155-163.

## NEMATODE RESOURCES

### Nematode Testing

(The following section was modified from pages 12-13 of the *2005 Plant Disease Management Handbook* published by Oregon State University, Washington State University, and the University of Idaho)

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The OSU Extension Plant Pathology, University of Idaho, and Washington State University perform nematode tests. A fee is levied for each sample of soil or roots tested. Contact individual labs for details on specific fees.

Information about plant-parasitic nematodes in soils and crops is increasingly important to Pacific Northwest growers for maintaining and improving crop production. Nematode detection is a standard laboratory procedure, although special facilities and personnel are required. Most nematodes in soils and plant tissues can be recovered and enumerated accurately. However, the weakness in the system is the method of sampling. Unfortunately, no one knows how to sample a field in a way that accurately represents nematode population distributions. Despite this problem, results from soil or plant samples will aid growers in planning their crop production programs. Decisions about soil fumigation and future cropping programs depend on knowing the kind and amount of plant-parasitic nematodes present.

The OSU Plant Disease Clinic Nematode Testing Service processes samples to help growers make decisions about crops, not to address regulations governing inter-and intra-state shipments. Contact the state Department of Agriculture for such testing.

### **Sample contents**

**1) Soil:** A composite sample of approximately 1-pint of soil is best for an accurate routine test to diagnose a plant problem or confirm nematode populations. Two quarts are required for a bioassay, but do not send this much soil without prior authorization. A soil tube 0.875 inches by 12 inches is the best sampling device, but trowels or shovels may also be used. Take the composite sample from at least 20 locations within no more than 5 acres. If sampling poor areas or weak spots, sample from the edge of these spots rather than from the middle. If plants of the crop in question are available, roots and surrounding soil should be included in the sample. When diagnosing a plant problem, soil samples from both the healthy and diseased part of the field will aid in interpreting the final results.

**2) Plants:** It is best to take a composite sample (10 or more root sub-samples within the 5-acre area) for an accurate routine test for root-dwelling nematodes. The sampler is responsible for ensuring that the roots in the sample bag belong to the species or cultivar named on the label. If the sampling area does not contain plants of the injured crop, it is possible to include an alternative host plant, such as clover or vetch for root-lesion nematodes.

**3) Information:** Please fill out a Nematode Test Form which is available from your county Extension office. Unlabeled samples have no value. The label should state: date, grower's name and address, location of sampling area, name and cultivar of crop last grown, and name and cultivar of crop to be planted. **Do not** let the label or form come into contact with the sample.

**4) Packing:** Standard soil test bags or polyethylene bags are satisfactory containers for samples as they maintain soil moisture. Avoid exposing samples to heat, such as direct sunlight or the inside of a hot vehicle. Because some nematode extractions rely on living, active nematodes, heat and drying must be avoided or results will be compromised. *Do not use paper bags, glass jars, cardboard boxes, sandwich bags, grocery store plastic bags, bread bags, or other thin plastic bags.* Attach a label or Nematode Test Form to the outside of the sample bag. Address the samples to:  
Idaho -

Dr. Hafez Saad  
SW Idaho Research & Extension Center  
University of Idaho  
29603 U of I Lane  
Parma, ID 83660-9637  
Tel: 208-722-6701, Email: shafez@uidaho.edu

Oregon -

Nematode Testing Service  
Department of Botany and Plant Pathology

Oregon State University  
1089 Cordley Hall  
Corvallis, OR 97331-2903  
Washington (fee of \$20/sample as of summer 2005) -  
Dr. Katerina Riga  
Washington State University Prosser IAREC  
24106 N. Bunn Road  
Prosser, WA 99350-8694  
Tel: 509-786-9256, Email: riga@wsu.edu

### **Interpreting Nematode Test Reports**

Nematode test reports must be interpreted properly before a management decision can be made. Most laboratories use different forms to report results, but all contain essentially the same information. When interpreting the information on these forms, consider units of nematode density, extraction method, nematode species, time of year, and damage thresholds.

**1) Units of Nematode Density:** Different laboratories report nematode densities on different bases. In addition, damage-threshold levels are reported in a variety of different units. If you send samples to only one laboratory, interpreting its report of density units is less of a problem. Be aware of the type of density unit expression your laboratory uses to report results. If necessary, ask your lab to explain its system of expressing density units to you.

Nematode densities (or counts) may be expressed on the basis of weight (for example, number of nematodes per gram of soil) or volume (such as number of nematodes per cubic centimeter or pint of soil). Counts also may be expressed on the basis of wet or dry soil. Generally, counts based on weight are more consistent than those based on volume. If an adjustment is not made for the amount of water in the soil, however, counts based on weight can be variable. Nematode counts from roots or other plant material are usually expressed by weight of soil but may be based on either fresh or dry weight depending on the lab processing the samples.

Understanding density units is critical in making treatment decisions. For example, a field may need treatment when there are more than 100 root-lesion nematodes per 500 grams of soil. If the laboratory reports the density as 50 root-lesion nematodes per 100 grams soil, one might conclude that the field does not need treatment. However, this density converts to 250 nematodes per 500 grams of soil, which indicates a different treatment decision.

**2) Extraction Efficiency:** Several methods can be used to extract nematodes from soil and plant tissue. Each method produces different nematode counts based on the number of live nematodes, duration of extraction, soil type, and nematode species present. Problems can occur when different laboratories' results are compared with one another or with thresholds reported in the literature. Again, if you send samples to only one laboratory, interpreting extraction methods is less of a problem.

Baermann funnel extraction requires several days and recovers only live nematodes. Extractions using density centrifugation are faster and yield both living and dead nematodes. The number of nematodes extracted from roots after only 1 day will be about 10% of the number recovered if roots are extracted for 1 week. Extraction efficiency is higher for lighter soils than for heavy soils.

Some nematode species are more efficiently extracted by a particular method. For example, ring nematodes are best recovered by density centrifugation and may be underestimated if Baermann funnel techniques are used.

**3) Nematode Species:** Almost all laboratories provide the common and/or generic name of all plant-parasitic nematodes recovered from a sample. However, different nematode species within a give genus may damage a crop differently. Species identification may therefore be important, but it is more difficult than routine nematode tests and may require an extra fee. In mint, for example, pin nematodes can be very damaging, but there is no data to show that different species produce different levels of damage. Therefore, knowing the species of a particular pin nematode in a mint field is not important. On the other hand, barley root-knot (*Meloidogyne naasi*), Columbia root-knot (*M. chitwoodi*), and northern root-knot (*M. hapla*) may be found on crops grown in rotation with mint. Any of these nematodes may be in a sample taken before mint is planted; however, only northern root-knot nematode will damage mint.

**4) Time of Year for Sampling:** Population densities of nematodes go through cycles during the year. A count of five nematodes per 100 grams of soil, at the low part of a nematode's population cycle, represents a greater threat than the same count at the peak of the population cycle. If soil samples for a particular nematode species are always taken at the same time of the year, interpreting the results is much easier.

**5) Damage Level Information:** Ultimately, the number of nematodes in a soil sample taken at a certain time relates to the damage that the nematodes may cause the crop. Some quantitative damage figures for nematode-crop interactions in the Pacific Northwest are available but have been difficult to find. The OSU Nematode Testing Service is in the process of compiling damage figures for Pacific Northwest crops. Five text documents listing host range and damage levels by plant and nematode species with crop groups are available on the Nematodes in Oregon Agriculture web site:

<http://mgd.nacse.org/hyperSQL/squiggles/>

and may be searched using your web browser's "Find a File" function. Hard copies of some text documents are also available from:

OSU Nematode Testing Service  
Department of Botany and Plant Pathology  
Oregon State University 1089 Cordley Hall  
Corvallis, OR 97331-2903

The experience of local growers, crop consultants, and Extension agents also is valuable in making management decisions. In general, a healthy crop can withstand higher nematode densities than crops stressed by factors such as a lack of water or nutrients, or the activity of other pests. Damage usually is greater on sandy soils.

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In addition to university diagnostic labs that offer nematode testing services, the following extension bulletin lists private diagnostic labs in the Pacific Northwest, some of which provide nematode assays: *Analytical Labs and Consultants Serving Agriculture in the Pacific Northwest*. Bulletin # EB 1578e at

<http://cru.cahe.wsu.edu/CEPublications/eb1578e/eb1578e.pdf>

### Resources on Plant Parasitic Nematodes & Their Management

- *The PNW Plant Disease Management Handbook* includes a section on *Nematodes*, by Ingham and Jensen, and management recommendations listed under specific host crops. Much of this information can be viewed on-line in the *Online Guide to Plant Disease Control* published by Oregon State University Extension at: [http://plant-disease.ippc.orst.edu/articles.cfm?article\\_id=1](http://plant-disease.ippc.orst.edu/articles.cfm?article_id=1)
- *Plant Parasitic Nematodes* by Merrifield and Muir at Oregon State University: <http://mgd.nacse.org/hyperSQL/squiggles/> This website mixes science with a little bit of fun, and includes a section titled "ROOT-PARASITIC NEMATODE HOST RANGE AND DAMAGE LEVELS ON OREGON VEGETABLE CROPS".
- The *Plant Pathology Internet Guide Book* at <http://www.pk.uni-bonn.de/ppigb/ppigb.htm> includes a link to many nematology resources. Click on the "Nematology" link on the left side of the page.
- The *Society of Nematologists* website is located at: <http://www.pk.uni-bonn.de/ppigb/ppigb.htm>
- WSU extension bulletins on nematode pests and their management can be ordered at the WSU Extension Bulletins website (<http://cru84.cahe.wsu.edu/cgi-bin/pubs>):
  - *Pea Cyst Nematode: Biology and Prevention*. Bulletin # EB1872 can be downloaded free-of-charge at <http://cru.cahe.wsu.edu/CEPublications/eb1872/eb1872.html>
  - *Root Knot Nematodes of the Pacific Northwest*. Bulletin # PNW 0190 at <http://cru84.cahe.wsu.edu/cgi-bin/pubs/PNW0190.html?id=wNlpTvBm>

- *Sampling for Nematodes in Soil*. Bulletin # EB1379 at <http://cru84.cahe.wsu.edu/cgi-bin/pubs/EB1379.html?id=wNlpTvBm>
- *Mustard*. Bulletin #1952E can be downloaded free-of-charge at <http://cru84.cahe.wsu.edu/cgi-bin/pubs/EB1952E.html?id=wNlpTvBm>  
Farmers and researchers are investigating several types of mustard for their ability to suppress soilborne disease, nematodes, and weeds, and to build soil quality.
- *Sudangrass and Sorghum-Sudangrass Hybrids*. Bulletin # EB1950E can be downloaded free-of-charge at <http://cru84.cahe.wsu.edu/cgi-bin/pubs/EB1950E.html?id=wNlpTvBm>. Sudangrass and Sorghum-Sudangrass hybrids are heat and drought tolerant cover crops that can be used to scavenge residual N, suppress weeds, suppress certain diseases and nematodes, and build soil quality.
- The American Phytopathological Society has published the following practical reference on plant parasitic nematodes *Diagnosing Plant Diseases Caused by Nematodes*, authored by M.C. Shurtleff and C.W. Averre III. Information on ordering the book can be found at: <http://store.yahoo.com/shopapspress/42546.html>