Grape Nematode Problems

Nematodes are translucent, microscopic roundworms, typically measuring 0.25 to 1 mm in length and only about 0.1 to 0.2 mm in diameter. Most nematodes in soil are beneficial components of the soil ecosystem, where they feed on bacteria, fungi and other micro-invertebrates, stimulating and regulating the turnover of nutrients. Their abundance ranges from about 500 per liter of degraded or infertile soil, up to 50,000 per liter of highly fertile soil. Some nematode species, however, parasitize plant roots and are economically important plant pathogens. In degraded agricultural soils, plant-parasitic nematodes often outnumber the beneficial nematodes.

General symptoms

All plant-parasitic nematodes use hollow spear-like mouthparts called "stylets" to feed on plant roots. A few nematode species do not cause much direct damage on their own, but can transmit viruses while they are feeding (see section on dagger nematodes, below). Most species cause direct damage, including gall-like malformations that impair root function (see root-knot nematodes, below), dieback of root tips and formation of lesions on the roots (see root-lesion nematodes, below), or generally stunted root growth without these other signs of nematode feeding (see ring and dagger nematodes, below). When plant-parasitic nematode population densities are large, root systems will generally be sparse, there will be few fine roots, and the damaged roots will appear brown or black rather than a healthy white or tan color. Vines severely damaged by plant-parasitic nematodes are stunted and have reduced yields.

At the field level, nematode damage is often overlooked because the above-ground symptoms are non-specific and difficult to distinguish from effects of other factors. Nematode populations usually exist in patches of high population densities; rarely, entire fields will be uniformly affected. Thus typical symptoms include poor vine vigour in patches of one to dozens of vines. This patchy, uneven growth caused by plant-parasitic nematodes may occur within a vineyard with uniform soil conditions. Areas with high nematode population densities may also be correlated with other soil factors that can affect vine vigour. For example, many species of plant-parasitic nematodes reach higher populations and cause more damage in sandy soils than in finer-textured soils. As a result, poor vine growth in sandy soils can be the result of low water or nutrient availability as well as the interaction of these additional stresses with nematode damage.

Nematode species

The main groups of plant-parasitic nematodes of concern for winegrape production in British Columbia are ring nematodes (*Mesocriconema xenoplax*), dagger nematodes (*Xiphinema* species), root-knot nematodes (*Meloidogyne hapla*) and root-lesion nematodes (*Pratylenchus penetrans*). Vineyards in British Columbia often have multiple species of plant-parasitic nematodes.

Ring nematodes (*Mesocriconema xenoplax*): These nematodes are ectoparasites that use long stylets to extract the contents of root cells, especially at root tips. Their preferential feeding at root tips causes some stunting and sometimes formation of swollen or malformed root tips, often without any obvious necrosis or rotting of the roots, but at high population densities root necrosis and dieback will be observed. Ring nematode feeding ultimately causes impaired root functioning and shifts in plant carbon allocation that in-turn result in overall declines in vigor and enhanced susceptibility to other stresses. Preferred hosts for ring nematodes include cherry, peach, apricot, and plum in addition to grape. These nematodes are recognized as significant

pests in California and Oregon. Ring nematodes have recently been found to be relatively widespread in the Okanagan Valley.

Root-knot nematodes (*Meloidogyne hapla*): These nematodes are endoparasites. Infective juveniles invade root tips and establish permanent feeding sites. As the nematodes feed and mature in the root, galls or "knots" of root tissue form around them. These galls, which typically range in size from 3 to 12 mm in diameter, interfere with water and nutrient uptake. Several species of root-knot nematodes are recognized to be significant pests of grape in most grape-growing regions. To date, only one species has been found in BC vineyards, *Meloidogyne hapla*. The damage caused by *M. hapla* has not been studied as extensively as other species, and its impact on grapevine health under Okanagan growing conditions is not clear.

Dagger nematodes (*Xiphinema* species): Several closely related species of *Xiphinema*, all of which were previously lumped under the species *Xiphinema americanum*, are commonly found in BC vineyards. These nematodes are ectoparasites; they do not burrow into roots, but insert their long stylets deep into root tips, where they feed preferentially on root tip cells. Dagger nematode feeding causes some stunting and swelling of root tips, but not necrosis. Dagger nematodes seldom cause significant damage on their own, and are mostly important as vectors of viruses; *X. americanum* and related species transmit *Tomato ringspot virus*, *Tobacco ringspot virus*, *Peach rosette mosaic virus* and several other minor viruses.

Xiphinema index transmits the devastating *Grapevine fanleaf virus*. This species is also more directly pathogenic to grapevine than all other species of dagger nematodes and can cause significant damage in the absence of the virus. Plant protection measures that require treatment of imported planting stock have thus far prevented *Xiphinema index* from being introduced into British Columbia.

Root-lesion nematodes (*Pratylenchus* species): These nematodes are migratory endoparasites, burrowing into roots to feed, and migrating freely between root tissue and soil. Root-lesion nematodes cause symptoms that range from many small lesions on young feeder roots to abnormal darkening and necrosis or death of the roots. Severely damaged root systems will have few newly formed feeder roots and sparse tufts of fine roots that will be blackened and crumbly. Most research documenting impacts of root-lesion nematodes has been conducted on *Pratylenchus vulnus*, a species that is not known to occur in BC. The species most commonly found in the Okanagan Valley is *P. penetrans* which is widely recognized as a parasite of fruit trees and a wide range of other crops and weed species. Recent trials at the Summerland Research and Development Centre indicate that *P. penetrans* does not effectively parasitize grapevines. It probably persists in BC vineyard soils via feeding on grasses and weeds, and is probably of no consequence to grapevine health.

Nematode Testing

Nematodes are best managed before planting new vineyard blocks, as there are no chemical treatments for nematodes that can be used on established vines in Canada. Having soil tested for plant-parasitic nematodes before planting is therefore an important first step to determine if nematode management practices are warranted (see below).

Sampling strategies and interpretation of the results depend on the nematode species suspected and environmental conditions, and should be developed in consultation with a diagnostic laboratory. Populations of all nematode species vary seasonally. Since some nematode species migrate between roots and soil, it is usually necessary to collect both soil and root samples for testing. The laboratory analysis includes extraction of nematodes from soil and plant tissue,

identification of the species present, and enumeration. The absence of recognized nematode pathogens in diagnostic samples can be used to rule-out nematodes as the cause of poor crop growth.

Soil analysis for the presence of nematodes is provided by the following laboratories. Contact the labs directly for information on fees and sampling instructions:

BC Ministry of Agriculture and Lands
Plant Diagnostic Laboratory
Abbotsford Agriculture Centre
1767 Angus Campbell Road
Abbotsford, BC V3G 2M3
Tel: 604-556-3126 (directly)
Toll Free: 1-800-661-9903
Web: http://www.al.gov.bc.ca/cropprot/lab.htm

A&L Canada Laboratories
2136 Jetstream Rd
London, Ontario Canada
N5V 3P5
Tel: (519) 457-2575
Toll Free:1-(855)-837-8347
Fax: (519) 457-2664
alcanadalabs@alcanada.com
Web: https://www.alcanada.com/content/solutions/nematode

Damage Thresholds

Pre-plant nematode population densities that can be expected to reduce establishment and vigour of young vines in the first few years after planting varies among nematode species. For ring nematodes, population densities in excess of about 100 ring nematodes /100 cm^3 soil will cause measurable damage to susceptible rootstocks or self-rooted vines under most conditions. Pre-plant damage threshold populations for root-knot and dagger nematodes are less certain than for ring nematodes in BC, but have been estimated at 200 root-knot nematodes /100 cm^3 soil and 50 dagger nematodes /100 cm^3 soil.

It is very difficult to interpret damage threshold populations for established vineyards. This is because perennial crops accumulate stresses, nematode feeding in one year can influence vine growth in subsequent years, and nematode populations may decline after peaking at damaging levels, obscuring relationships between population densities and vigour. As well, nematode effects can exacerbate or become obscured by other pests, pathogens and abiotic stresses that have cumulative impacts on vines that are more than a few years old.

Nematode Management

Planting Material & Nematode Resistant Rootstocks:

Regardless of whether resistant rootstocks are being planted or not, it is critical to use certified planting material to prevent the introduction of nematodes of concern to new vineyards.

Rootstocks that are resistant to plant-parasitic nematodes are available. Rootstocks reported to be resistant to ring nematodes include 420A, 101-14 Mgt, 110R, UCD-GRN1, and UCD-GRN5.

The latter two are recent releases from the University of California–Davis rootstock breeding program; two other rootstocks from that program, UCD-GRN3 and UCD-GRN4, are rated as moderately resistant. One population of ring nematode from California is able to parasitize and damage 420A, 101-14 and 110R, suggesting that those rootstocks may not be resistant to all geographically distinct populations of ring nematodes.

A number of rootstocks have been reported to be resistant to root-knot and/or dagger nematodes, including: Dogridge, Harmony, Freedom, Ramsey, 1613C, RS-3, RS-9, USDA 10-17A and USDA 10-23B in addition to UCD-GRN1, UCD-GRN2, UCD-GRN3, UCD-GRN4, and UCD-GRN5. It is important to note, however, that these rootstocks have been evaluated against the species of dagger and root-knot nematodes found in California and other Mediterranean climate regions, not against the species in BC. Consequently, it is not clear if they would express the same tolerance or resistance to nematode species found in BC.

Pre-plant Soil Fumigation:

Soil fumigation with chemicals such as Vapam (metam-sodium) and Basamid (dazomet) are an option for reducing the populations of plant-parasitic nematodes in soil prior to planting. They will also help to reduce the levels of other soil-borne plant pathogens and viable weed seeds.

New regulations for soil fumigants came into effect in September 2014. These include the requirement for a detailed fumigation management plan, following good agricultural practices, implementing buffer zones and an emergency management plan. All soil fumigants are now restricted products and require certification of all fumigant handlers and applicators. Read and understand the entire product label before using. Labels contain detailed information on the new requirements for use, including what is needed in the fumigation management plan.

Soil must be well prepared before fumigation, and should be moist. As many old grape roots should be removed as possible. These products release toxic gases on contact with moist soil. Following application, the soil surface should be sealed by watering and rolling or with polyethylene sheets. Refer to the product labels for detailed information on application, safety precautions, personal protective equipment and buffer zones.

Soil fumigation is expensive. Before considering fumigation, have samples of your soil analyzed for nematodes.

Alternatives to fumigation:

"Biofumigation" refers to the incorporation of naturally-occurring materials such as manure slurries or green manure cover crops into soil to induce conditions that are temporarily noxious to nematodes. Variations on biofumigation are the most effective alternatives to chemical fumigation for reducing plant-parasitic nematode populations before planting. Biofumigation is generally not as effective as chemical fumigation, but it can have the additional benefit of enhancing soil organic matter and fertility. Green manure cover crops that are known to be particularly effective as biofumigants include many varieties of plants in the brassica family, including white mustard (*Brassica hirta, Sinapsis alba*), Indian brown mustard (*Brassica juncea*), Canola/oilseed rape (*Brassica napus, Brassica rapa*), and forage radish (*Raphanus sativus*). Varieties of sudangrass have also been shown to have biofumigant effects when incorporated as green manure.

Preplant incorporation of composts does not actually reduce nematode populations like biofumigant materials, but it can stimulate populations of nematode-suppressive microbes that

help prevent population densities of plant-parasitic nematodes from increasing to problematic levels. Composts also effectively enhance soil organic matter and fertility, and may thereby promote root growth enough to compensate for the effects of parasitic nematodes. Depending on which species of nematodes are present, it may also be possible to minimize their populations by rotating to non-host crops for a year before planting grapevines. Rotation to a non-host crop will not guarantee a reduction in nematodes, as populations may be sustained on weeds contaminating the non-host crop.

Soil solarization is a non-chemical technique that will help to reduce the population of nematodes and other soil-borne pests. Solarization involves capturing the heat of the sun by covering the soil with transparent polyethylene plastic sheets during warm sunny months. The soil temperatures under the plastic increase to levels lethal to many soil-borne plant pathogens, weed seeds, seedlings, and nematodes. It is usually necessary to take the land to be solarized out of production for a year. Soil should be tilled before solarization, and should also have a good soil moisture level. The area to be treated should be free of weeds, plant debris, and large clods which would raise the plastic off the ground. Cover the area with a double layer of clear polyethylene sheet, seal the edges with soil and leave it in place for 4-6 weeks during the heat of the summer (mid-June through mid-August). If possible, leave the poly in place until replanting to prevent re-contamination.