

Nematodes

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Pest Description and Crop Damage

Nematodes are non-segmented roundworms found in soil, water, and tissues of living organisms. Several species of nematodes are known to feed on hop roots. The most common species associated with hop is the hop cyst nematode, *Heterodera humuli*.

Plant-parasitic nematodes, such as those that feed on hop, are microscopic. They can impact hop directly through feeding or indirectly by creating infection sites for other pathogens or by vectoring viruses. The perennial nature of hop, the size of its root system, and its rapid growth rate during the spring suggest that hop plants may have a great capacity to tolerate nematode feeding. Nematode injury appears most likely to impact growth of young plants. Other stress factors, such as drought or heat, can exacerbate symptoms of nematode feeding.

Symptoms of nematode feeding injury on hop are likely to include general yellowing of leaves and poor growth in patches of yards that may expand over time. Plants in infested yards may be stunted, debilitated, and have reduced bine lengths. Accumulation of manganese (and, to a lesser extent, other nutrients) is reported to be impaired in young Cascade plants injured by hop cyst nematode. When symptoms occur in yards that cannot be attributed to other causes, nematodes should be considered as a possible cause.

Nematodes of Note

HOP CYST NEMATODE

The hop cyst nematode occurs in most hop production areas and is regarded as the most important plant-parasitic nematode on hop. Hop cyst nematodes generally undergo one to two generations per year. Eggs, contained within cysts, hatch into worm-like juveniles as hop plants break dormancy in the spring. The juveniles penetrate the hop roots and initiate feeding sites. Females are cream-colored, lemon-shaped, and approximately 1/20-inch long. Females can produce over 250 eggs, which are laid internally. After producing eggs, the females darken, harden, and die, forming protective cysts around their eggs.

Cyst nematodes in general are very destructive pathogens of their hosts. In

addition, they are very persistent, as they can lay dormant in the soil for a decade or more in the absence of hosts.

In a study in Australia, a 38% reduction in dry weight of hops per string was observed between plants in a yard with the highest population density of *H. humuli* and those with the lowest. Losses have not been documented or quantified in U.S. hop yards, but one study indicated that high population densities are required for extensive damage.

Importantly, hop cyst nematodes may interact with *Verticillium* spp. to reduce hop growth and increase the severity of wilt symptoms.

DAGGER NEMATODES

Dagger nematodes (*Xiphinema* spp.) are a concern in perennial cropping systems where viruses are major limiting factors. Dagger nematodes are vectors of nepoviruses, the most common on fruit in North America being *Tomato ringspot virus*. The most important nepovirus in hop production is *Arabis mosaic virus* (ArMV-H), which occurs in many countries, including Canada. However, ArMV-H and its primary vector, *X. diversicaudatum*, have not been detected recently in hop grown in the U.S. The most common species of dagger nematode found in Michigan and many fruit growing regions of the U.S. is the American dagger nematode, *X. americanum*. At this point, there are no reports of *X. americanum* serving as a vector for ArMV-H. *Strawberry latent ringspot virus* is another nepovirus found in hop, but it has only been reported in Europe.

LESION NEMATODES

The lesion nematode (*Pratylenchus penetrans*) is a species of plant-parasitic nematode commonly found in temperate regions. This nematode has an extremely wide host range, causing lesions on the roots of many agricultural crops. These wounds can facilitate the introduction of soil-borne fungi, including *Verticillium* spp. It is not known whether lesion nematodes predispose hop to infection by *Verticillium dahliae* or *V. nonalfalfae* (formerly known as *V. albo-atrum*), which cause wilt in hop. See *Verticillium Wilt* under Diseases.

At a Glance Nematodes

- ◆ Hop cyst nematode is the species most closely associated with hop.
- ◆ In most cases, the effect of nematodes is not sufficient to warrant control measures.
- ◆ Soil samples can reveal nematode infestation.
- ◆ Avoid planting into sites known to be infested with nematodes.
- ◆ Nematodes' role as a potential pest of hop is not well understood.



Figure 71. Sampling soil for plant-parasitic nematodes in a research hop yard. (G.W. Bird)

OTHER NEMATODES

Other nematodes known to be associated with hop include the potato rot nematode and needle nematodes. The most common needle nematode found in Michigan, *Longidorus elongatus*, has been found in hop yards in Germany but no hop yards in Michigan to date. In Michigan, it is confined to very sandy soils (>70% sand content). *L. elongatus* tends to be a very destructive nematode and it can also vector nepoviruses.

Root-knot nematodes (*Meloidogyne* spp.) cause the greatest amount of economic losses across the spectrum of agricultural crops worldwide. The northern root-knot nematode, *M. hapla*, is the most frequently encountered root-knot nematode species in temperate regions of the U.S. but has not been reported in association with hop.

Monitoring and Thresholds

As a rule of thumb, the site should be sampled for plant-parasitic nematodes before the establishment of any perennial crop to avoid future problems. While specific thresholds do not exist, infested sites remain infested and planting into them should be avoided. Hop cyst nematode females can be seen with the naked eye after they develop into egg-filled cysts and rupture through the epidermis of hop roots.

Management

Control of plant-parasitic nematodes in other perennial crops during the establishment phase has been shown to increase yields, but this has not been quantified in hop.

Avoidance is the key management strategy for nematode infestation in hop. Besides refraining from planting into heavily infested soil, planting stock should be certified as free of hop cyst nematodes. Hop cyst nematodes may be disseminated within and among hop yards in infested rhizomes and in irrigation water and floodwater. Sanitation of machinery, tools, and equipment moving within and between yards is also a key tactic in preventing the spread of nematodes.

Hop cultivars differ in their susceptibilities to hop cyst nematodes. In Oregon, cysts have been recovered from Backa, Brewer's Gold, Bullion, Fuggle, and Kent varieties, while in Idaho, Cascade was reported to be more heavily infested than other varieties.

Mocap EC (ethoprop) is labeled for use on hop in most states as a pre-plant and post-plant insecticide/nematicide. However, cyst nematodes can be difficult to control chemically and no information is available to suggest that Mocap use results in population reductions of hop cyst nematodes.

In most cases, hop seems to tolerate nematode feeding fairly well. Due to the rapid multiplication rates of most nematode species and the possible difficulties inherent in applying effective doses of nematicides, the use of these compounds is unlikely to be economical or effective once a yard has been established.