36. Nematodes

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Hosts

Seedlings of most tree species are susceptible to damage caused by plant parasitic nematodes. Some plant parasitic nematodes have wide host ranges that may include woody plants, cover crops, and weeds. Other nematodes favor only certain plant species. A large number of nematode species have been found to damage forest-tree seedling crops. Among the most damaging nematodes are the stunt nematodes (*Tylenchorhynchus* spp.), dagger nematodes (*Xiphinema* spp.), needle nematodes (*Longidorus* spp.), root-knot nematodes (*Meloidogyne* spp.), pine cystoid nematodes (*Meloidodera* spp.), lance nematodes (*Hoplolaimus* spp.), stubby-root nematodes (*Trichodorus* spp.), and lesion nematodes (*Pratylenchus* spp.).

Distribution

Plant parasitic nematodes can affect forest-tree seedling production in all areas of the United States. More nematode species, however, occur in warmer regions, and seedlings produced in the South are more likely to be affected. Some nurseries in the Midwestern and Pacific Northwestern United States and Western Canada have reported problems with several nematode species, but documented cases of damage are rare in nurseries located in other areas of the western and northern regions of the United States.

Damage

Plant parasitic nematodes feed directly on seedling roots resulting in damage to the root system. Nematode feeding can reduce nutrient uptake, suppress root elongation, and generally interfere with the normal metabolic processes of seedlings. Wounds created by nematodes can also serve as infection courts for fungal pathogens that further debilitate roots. Seedlings affected by nematodes lack vigor and are usually stunted, although even severely stunted seedlings will often survive in seedbeds until they are challenged with a period of soil moisture stress. Stunting caused by nematodes reduces seedling quality and can render seedlings unsuitable as planting stock. Seedlings are particularly vulnerable to damage by nematodes during the weeks that follow seed germination. Later in the growing season, larger seedlings can better withstand some nematode feeding without noticeable effects.

Diagnosis

Nematode feeding produces various symptoms in seedlings that can be helpful in alerting nursery managers to problems with nematodes, but correct diagnosis requires nematode extraction from soil and roots. Seedlings damaged by nematodes exhibit stunting, and foliage may be reduced in size and appear chlorotic (fig. 36.1). Seedling stunting may not be uniform throughout fields and can give fields a wavy appearance (figs. 36.1 and 36.2). The root systems of nematode-damaged seedlings are often greatly reduced in size compared with

Figure 36.1—*Chlorosis and stunting in slash pine seedlings caused by the stunt nematode* (Tylenchorhynchus claytoni). Photo by Michelle M. Cram, USDA Forest Service.

Figure 36.2—*Stunting in loblolly pine seedlings caused by the needle nematode* (Longidorus americanus). Photo by Stephen W. Fraedrich, USDA Forest Service.

undamaged, healthy seedlings (fig. 36.3). Nematode species such as root-knot or dagger nematodes may induce galls on roots, but most nematodes produce no such definitive symptoms. Less obvious symptoms produced by nematodes can include swelling of roots, lesions, or a reduction in root elongation. Wounds caused by nematodes may provide an entry court for fungal pathogens resulting in root rot and seedling wilting.

Cooperative extension offices, some Federal agencies, and private companies evaluate soil and plant samples for plant parasitic nematodes. A variety of techniques should be used to account for ectoparasitic and endoparasitic nematodes. Roots should be examined and sampled for endoparasitic nematodes, such as lance nematodes, and sedentary nematodes, such as root-knot nematodes. Soil extraction techniques with the Baermann funnel or the centrifugal flotation methods are often adequate for most ectoparasitic nematodes that are less than 2 mm in length. These extraction techniques may have to be modified for larger nematodes, such as needle nematodes, by using wider mesh screens in the Baermann funnel method or higher sugar concentrations in the centrifugal flotation method.

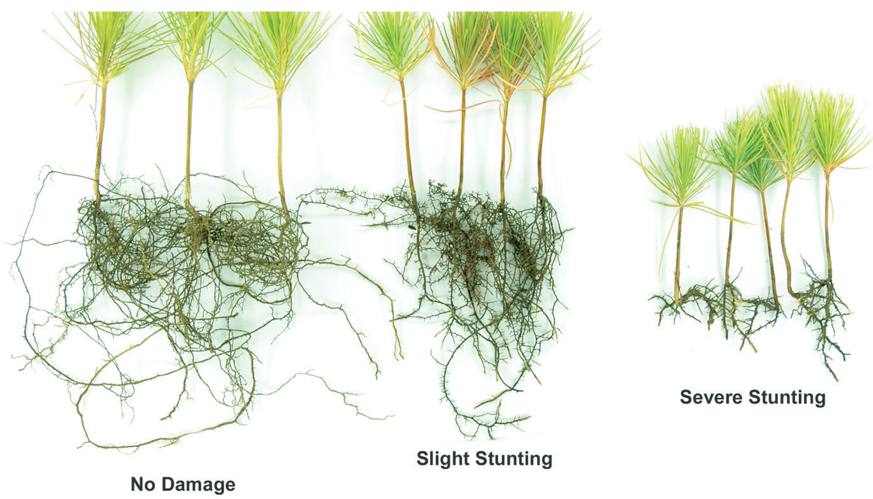

Figure 36.3—*Healthy loblolly pine seedlings (left), and seedlings exhibiting slight (center) and severe (right) stunting caused by the stunt nematode* (Tylenchorhynchus ewingi). Photo by Stephen W. Fraedrich, USDA Forest Service.

Biology

Most plant parasitic nematodes are worm-like for a least a part of their life cycle. Their lengths generally range from 0.5 to 2.0 mm, although some species, such as those in the genus *Longidorus,* can be up to 11 mm in length. Nematodes with sedentary stages, in which females attach to roots and swell as they feed, ultimately have a round to pear-shaped appearance. Plant parasitic nematodes possess a hollow stylet, which is used to puncture root cell walls and suck the contents from cells (fig. 36.4). Plant parasitic nematodes are either ectoparasites that feed outside the roots or endoparasites that burrow inside the roots to feed. Nematodes have an egg stage, and most go through four juvenile stages before reaching the adult stage. Usually, nematodes can complete their life cycle in just 3 to 6 weeks under optimum conditions, although some nematode species require 1 year or more to complete a life cycle. Nematodes are most common in the upper 30 cm (12 in) of soil but can occur deeper in soil. Some nematode species can also migrate vertically through the soil in response to temperature and moisture fluctuations.

Control

Prevention

Movement of plant parasitic nematodes by equipment is a primary way that infestations spread. After a field is identified as infested, restrict equipment movement through the field or wash any nematode-infested soil and debris off the equipment before moving to uninfested fields.

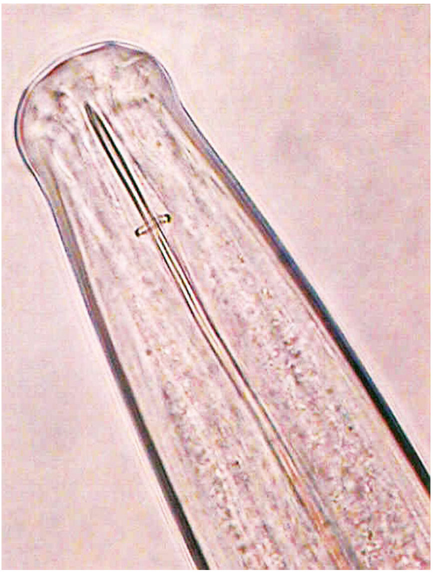

Figure 36.4—*Needle nematode* (Longidorus americanus) *head with long stylet.* Photo by Michelle M. Cram, USDA Forest Service.

Cultural

Crop rotations with nonhost crops can prevent the buildup of plant parasitic nematodes in nurseries. For instance, the needle nematode, *L. americanus*, feeds and reproduces on pines and oaks but does not feed on grasses such as sorghum-sudan and rye. In contrast, the stunt nematodes have wide host ranges that include pines, grasses, and legumes. Pearl millet varieties have been identified as nonhosts or poor hosts for many different plant parasitic nematodes, including species of root-knot, lesion, sting, and needle, and stunt nematodes. Information about the host range for individual nematode species is necessary to effectively use crop rotation.

The use of fallow can be an effective strategy for controlling many nematode species. Nematodes require host plants for survival in fields, and maintaining fallow fields can starve nematodes. This technique requires controlling weeds that might be hosts for the nematodes. Periodic soil disking or tilling can also hasten the decline of nematode populations in fields. Nematodes that can live in soil for extended periods without hosts, such as the dagger nematode *X. diversicaudatum*, are unlikely to be controlled by fallow or crop rotations and may require chemical controls.

Chemical

Broad-spectrum fumigants provide excellent control of plant parasitic nematodes. Fumigants are typically applied to the upper 15 to 20 cm (6 to 8 in) of soil and can significantly reduce nematode populations during the first year. However, fumigation may not eliminate nematodes in deeper soil layers, soil clods, or in roots not penetrated by fumigants. In addition, nematodes can be easily moved from infested fields to fumigated fields by equipment. Thus, nematode populations often rebound on seedling crops after fumigation, making it necessary to refumigate fields, rotate with nonhosts, or fallow before the next seedling crop.

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