



Solution sheet

Nematode – Cool Season

// The Problem

Nematodes are ubiquitous inhabitants of the soil microbe community and include both beneficial and plant-parasitic species. Plant-parasitic nematodes are commonly associated with the roots of all turfgrass species throughout the United States. In addition to naturally occurring in soils, nematodes can also be unintentionally introduced via sod, rhizomes or stolons. Parasitic nematodes are microscopic, unsegmented worms that use a needle-like mouthpart, called a stylet, to puncture the plant cell, inject digestive juices and then ingest the resultant plant fluids. Nematodes that feed on turfgrass roots are most abundant when the turf is actively growing, but populations can fluctuate based on the amount of turf root growth. Across a given area like a golf green, nematodes are unevenly distributed and are found in pockets of high populations which may change location within the green over time.

Nematodes feed as either endoparasites or ectoparasites. Some endoparasitic nematodes have sedentary adult females that feed and reproduce inside turf roots with the most common example being the root-knot nematode. Conversely, ectoparasitic nematodes spend their entire life feeding and reproducing in the soil surrounding the root system. These are the most diverse group of nematodes and include ring, sheath, spiral, sting, stubby root, and stunt nematodes (see table). Migratory endoparasitic nematodes are capable of feeding on both the inside and outside of turf roots and include lance, root-lesion and pin nematodes. Finally, foliar-feeding parasitic nematodes, such as *Anguina pacifica* (stem gall nematode) also exist, but only impacts *Poa annua* greens along the Pacific Coast of California, Oregon and Washington.

Several nematodes are associated with cool-season greens, including lance, ring, root-knot, sheath, spiral, stubby root and stunt. The sting nematode, adapted to warm climates, is generally absent in cool-season turf. In the absence of sting, root-knot and lance are considered the most problematic nematodes because they are commonly found in greens and, as endoparasites, can create significant disruption to roots. Even nematodes with a low risk of damage can injure greens when population densities reach peak levels. Sand content in the root zone has a major impact on plant-parasitic nematodes, and golf greens generally provide the optimum environment of well-drained sandy soils with soil moisture at or near field capacity.

What To Look For

In turf, there are few definitive symptoms or signs for consistent diagnosis of nematodes. Generally, the symptoms of nematode damage are similar to both biotic pest problems and abiotic nutritional deficiencies or environmental stresses. Above-ground symptoms include initial yellowing of turf, followed by wilting and slow recovery from wilt, poor turf response to fertilization and eventual thinning in irregular shapes ranging from inches to several feet in diameter. Symptoms are typically amplified by other plant stresses like high temperature stress or drought and usually reappear on the same greens year after year if left untreated. Below-ground symptoms include short stubby roots with few branch roots compared to healthy roots. Roots may have a dark brown color, galls and swellings, and sometimes exhibit swollen root tips which can have a crook or 'hawk beak' appearance. In addition to direct feeding, nematodes can enhance fungal infection from root-infecting diseases like summer patch and Pythium root rot resulting in greater turf damage.

// Nematode Thresholds

Each nematode in turf differs in their ability to cause damage. Established population thresholds are used to help predict nematode damage and assist in determining if intervention is needed. Nevertheless, nematode thresholds can be difficult to interpret without university and industry resources to help. This is because a combination of nematodes are often present and other factors influence the turf's tolerance to root-feeding, including species/cultivar, growing environment, management practices and disease activity.



Ring nematode injury to a creeping bentgrass/*Poa annua* green in Ohio (Bayer)



Sting nematode injury to a creeping bentgrass green in Kansas (Bayer)

Common Nematodes of Turfgrass

Relative Pathogenicity	Plant-parasitic Nematode ¹	Genus (Used to Identify)	Primary Turf Host ²	Damage Potential	Feeding Habit	
Highest	Sting	<i>Belonolaimus</i>	WS, CS	Very High	X	
	Needle	<i>Longidorus</i>	CS	Very High	X	
	Awl	<i>Dolichodorus</i>	WS	Very High	X	
	Root-knot	<i>Meloidogyne</i>	CS, WS	High		X
	Lance	<i>Hoplolaimus</i>	CS, WS	High	X	X
	Stubby Root	<i>Trichodorus</i>	WS, CS	High	X	
	Spiral	<i>Peltamigratus</i>	WS	High	X	
	Stem Gall	<i>Anguina</i>	Poa	High	X	X
	Stunt	<i>Tylenchorhynchus</i>	CS	Medium	X	
	Cyst	<i>Heterodera</i>	CS, WS	Medium		X
	Stubby Root	<i>Nanidorus</i>	WS, CS	Medium	X	
	Sheath	<i>Hemicyliophora</i>	WS, CS	Medium	X	
	Sheathoid	<i>Hemicriconemoides</i>	WS, CS	Medium	X	
	Root-lesion	<i>Pratylenchus</i>	CS	Medium	X	X
	Dagger	<i>Xiphinema</i>	CS	Medium	X	
	Ring	<i>Mesocriconema</i>	CS, WS	Low	X	
	Spiral	<i>Helicotylenchus</i>	CS, WS	Low	X	
Lowest	Pin	<i>Paratylenchus</i>	WS	Low	X	

¹Lance and spiral are the only nematodes not on the Indemnify label.

²CS = cool-season, WS = warm-season and Poa = *Poa annua*.

// Management Strategies

Cultural management strategies are vital in the prevention of severe nematode damage. Healthy turf with a robust root system can often tolerate nematode feeding with minimal if any damage. Implement cultural practices that promote root growth and health, including raising the height of cut, using lightweight mowing and rolling equipment to minimize compaction, applying balanced fertility, aerifying, proper irrigation and using a strategy of preventive fungicides to manage turf diseases. If the turf root system is severely damaged by nematodes, apply foliar nitrogen since it is more readily available to the plant and apply a nematicide.

Bayer's newest solution for nematodes is Indemnify[®] which is a true nematicide. It controls on-contact root-feeding nematodes including but not limited to sting, root-knot, and stunt and the foliar-feeding nematode *Anguina pacifica*. Indemnify can be used as a preventive or curative to control nematodes and application is straightforward with minimal personal protection equipment. Indemnify should be applied prior to and during active root growth to maximize turf recovery following periods of significant turf stress.

//// Nematode Solutions

Indemnify Uses	Timing (When to Apply)	Application Rate (fl oz Product / 1000 ft ²)	Application Interval
Preventive: turf is not damaged but history or lab diagnosis suggest damage is imminent	Begin applications when conditions are favorable for root growth	0.195 - 0.39 ¹	

Curative: turf is damaged	As needed to control nematodes when turfgrass is under stress	Spot treatment ² 0.39	2 - 4 weeks
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¹Do not apply more than 17.1 fl oz of Indemnify (0.446 lbs. a.i.) per acre per year.

²When making curative spot treatments, treat no more than 10,000 sq. ft. per acre per year and do not exceed 4 applications.

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