Agriculture: Tomato Pest Management Guidelines

Root-Knot Nematode

Meloidogyne spp.

Description of the Pest

Mature female root-knot nematodes are pear-shaped and about 0.01 inch long. Root-knot nematodes spend most of their life in galls(/PMG/FIG/tom-f33.html). Mature females(/PMG/M/N-RK-MSPP-AD.001.html) resemble tiny, white pearls; they sometimes can be seen with the use of a hand lens when root galls are cut open.

Damage

Root-knot nematodes cause characteristic galls on roots; galls may be up to 1 inch in diameter, but are usually smaller. These galls interfere with the flow of water and nutrients to the plant; infected plants appear less vigorous than healthy plants, may be yellowed, are prone to wilt in hot weather, and respond poorly to fertilizer. Damage areas usually appear as irregular patches and are frequently associated with lighter-textured soils.

Management

Assess the population level and damage potential based on soil sampling or the history of injury in previous crops. Because root-knot nematodes feed and multiply on many weed species, weed control is an important aspect of their management.

Cultural Control

Several varieties are resistant(/agriculture/tomato/Variety-Selection/) to nematodes and should be used where nematodes are present. Rotation with resistant varieties and nonhost crops is as effective as fumigation. Resistant tomato varieties are not effective against the species *Meloidogyne hapla,* but are effective against *M. incognita, M. javanica,* and *M. arenaria.* Cotton is susceptible only to *M. incognita* and has relatively high tolerance to even that species. Certain varieties of alfalfa and black-eyed peas are resistant to some root-knot species, but *M. hapla* builds to high numbers on alfalfa.

Soil solarization can provide control of many soilborne diseases, nematodes, and weed pests. For further information, contact your local farm advisor or see UC ANR Publication *Soil Solarization: A Nonpesticidal Method for Controlling Diseases, Nematodes, and Weeds*(https://anrcatalog.ucanr.edu/pdf/21377.pdf).

Organically Acceptable Methods

Cultural control is acceptable for use on an organically certified crop.

Monitoring and Treatment Decisions

Although soil sampling provides more detailed information, checking for root galls is a simple way to confirm that aboveground symptoms are caused by root-knot nematode injury. Check the roots of a few plants in midseason or later, even if the crop appears healthy. Check earlier if you see wilting, poor growth, or other symptoms; galls(/PMG/M/N-RK-MHAP-CD.004.html) may appear as soon as a month after planting. Carefully brush or wash soil from roots to look for galls. Be sure to check some plants in the sandiest part of the field, where damage is most likely.

Check the roots of rotation crops as well, but remember that galls will not be present on nonhost crops and may not be as obvious on other susceptible crops as on tomatoes. If the field has been fallowed or planted to a nonhost crop, look for root galls on nightshades and groundcherries. Other weeds may also have galls but are less reliable indicators of root-knot activity.

If you find galls on any host plant, you can assume that susceptible varieties of tomatoes in the same soil would be infected. However, absence of root galls on other plants does not necessarily mean the soil is free of nematodes that could injure tomatoes.

Soil Sampling

Soil sampling provides the best basis for management decisions, especially in coarse textured soils. You can sample whenever the soil is in good working condition, but the best times are in spring before planting and in fall after harvest. Because of the gradual decline in populations over the winter and the gradual increase during summer, samples from fall and spring represent the high and low extremes of the population. Sampling at other times yields immediate results that are more difficult to interpret.

Farm advisors can help you find a laboratory equipped for extracting and identifying nematodes from soil samples. The analysis usually takes about 2 weeks; allow enough time before planting to choose varieties and to treat the soil if necessary. Contact the lab, before you start, to ensure that samples can be processed as soon as they are received. Follow these instructions, but also consult the lab for any special instructions.

- Draw a field map showing areas that differ in soil texture, cropping history, or crop injury.
- Use a grid pattern to divide each area into blocks of 10 acres or less; if conditions are uniform throughout the field, apply the grid to the whole field.
- Use an auger or soil tube(/PMG/C/S-NC-CULT-SO.001.html) to collect soil from at least 20 places in each block. Take moist soil from a depth of at least 18 inches; take deeper samples in dry, fallow ground. Avoid places where soil is too wet or compacted; if surface soil is dry, discard it and include only moist soil. Samples should include roots of any crops or weeds that might be present.
- Thoroughly mix the soil from one block in a bucket or large bag, then transfer it to a plastic bag or other moisture-proof container.
- Label the sample with the block number in pencil on the outside of the container; moisture will ruin labels placed inside.
- Keep the samples cool; do not leave them in the sun or freeze them. The best storage temperature is 50° to 60°F. Seal the containers so they will not dry out. A good way to keep samples in good condition is to put them in an ice chest in the field.
- Send or deliver samples to the lab immediately. Ship them in an ice chest or in a box insulated with newspaper.

Interpreting the Results

The number of root-knot juveniles in soil samples can be a reliable guide to potential yield loss in processing tomatoes; below a certain level, the population has no measurable effect, but yield declines as the number of nematodes increases. If lab results are to be useful, however, you must interpret them carefully.

Labs generally report the number of root-knot juveniles found in a certain weight of soil, usually 100 grams or 1 kilogram. The most common extraction apparatus, the Baermann funnel, extracts only those juveniles already free in the soil; an added mist chamber improves accuracy by promoting the hatching of juveniles from any eggs the samples may contain. All reports should specify the extraction method used.

If your lab reports the estimated total number of juveniles in soil samples, you can use these figures directly in making management decisions. If the lab only reports the number extracted from the samples, then you must also know the recovery rate, or efficiency, of the lab procedure. The recovery rate tells you what percentage of the nematodes in samples were actually extracted; for root-knot juveniles, it is usually from 10 to 30%. To get the total, divide the number extracted by the recovery rate and multiply by 100. For example, if the lab extracted 30 juveniles per kilogram and the recovery rate is 20%, the total would be (30÷20) x 100, or 150 per kilogram. When comparing results from two sets of samples, make sure the same unit of soil weight was used in both cases; otherwise, adjust the figures accordingly before comparison.

The table below is a guide to yield loss that can be expected from a given root-knot nematode population in the San Joaquin Valley. With an estimate of expected yield loss, you can judge whether management options will increase net return. For example, if a lab finds 200 juveniles per kilogram in spring samples of sandy loam soil, the expected yield would drop to about 88% of normal. If normal yield were 30 tons per acre, the yield loss would be 12% of 30, or 3.6 tons per acre. When tomatoes are worth $54 per ton, the value of the loss is $54 x 3.6, or $194.40 per acre. If the cost of soil treatment is less, it will increase net return. The same logic applies to selection of a resistant variety or alternate crop that may cost more to plant or have lower value.

The table is based on samples taken in sandy loam soil; on finer textured soils, such as silt loams or clay loams, the expected yield reduction for a given population would be less than the value in the table. It would also be somewhat lower in areas with cooler springtime soil temperatures. The expected loss would be higher in hot desert soils and in the presence of Fusarium wilt.

Effect of Root-Knot Nematodes on Processing Tomato Yield in San Joaquin Valley Sandy Loam Soils

Number of Root-Knot Juveniles Per Kilogram in Soil Samples		Percent of Normal Yield
Fall samples	Spring samples	%
0-160	0-25	100
310	50	98
620	100	95
940	150	91
1250	200	88
1560	250	85
1870	300	82
2190	350	79
2500	400	77
2810	450	74
3120	500	72
3440	550	69
3750	600	67
4060	650	65
4370	700	63
4690	750	61
5000	800	60

Number of Root-Knot Juveniles Per Kilogram in Soil Samples		Percent of Normal Yield
5310	850	58
5620	900	56
5920	950	55
6250	1000	53

There is no formula for predicting yield loss outside the San Joaquin Valley, but analysis of soil samples in other areas can show whether a population is changing from year to year and can identify parts of the field where root-knot nematodes are concentrated. Although the numbers may differ, the general relation between population and yield is probably similar in all areas.

Several kinds of nematodes other than root-knot nematodes are found in tomato soils and may be listed in lab reports. These include stunt nematodes (*Tylenchorhynchus* spp.), spiral nematodes (*Heliotylenchus* spp.), pin nematodes, (*Paratylenchus* spp.), and stubby root nematodes (*Trichodorus* and *Paratrichodorus* spp.). None of these affect tomato in California; they generally feed on rotation crops or weeds. Certain root lesion nematodes (*Pratylenchus* spp.) injure tomatoes in other states, but the most common species in California tomato soils, *P. thornei,* feeds on grasses and small grains.

	Common name	Amount to use**	REI‡
	(Example trade name)	(dosage/acre)	(hours)

Pesticide precautions

Protect water

Calculate VOCs

Protect bees

Not all registered pesticides are listed. The following are ranked with the pesticides having the greatest IPM value listed first—the most effective and least likely to cause resistance are at the top of the table. When choosing a pesticide, consider information relating to the pesticide's properties and application timing, honey bees(/beeprecaution/), and environmental impact(/mitigation/index.html). Always read the label of the product being used.

PREPLANT			
A.	1,3-DICHLOROPROPENE* + CHLOROPICRIN*		
	(InLine)	Label rates	See label
	COMMENTS: Multi-purpose liquid fumigant for the preplant treatment of soil against plant-parasitic nematodes, symphylans and certain soil-borne pathogens using drip irrigation systems only. Use of a tarp seal is mandatory for all applications of this product. Fumigants such as 1,3-dichloropropene are a source of volatile organic compounds (VOCs) but are minimally reactive with other air contaminants that form ozone. Fumigate only as a last resort when other management strategies have not been successful or are not available.		
B.	1,3-DICHLOROPROPENE*		
	(Telone EC)	Label rates	See label

	Common name	Amount to use**	REI‡
	(Example trade name)	(dosage/acre)	(hours)
	COMMENTS: Liquid fumigant for the preplant treatment of soil against plant-parasitic nematodes and certain other soil pests in cropland using drip irrigation systems only. Fumigants such as 1,3-dichloropropene are a source of volatile organic compounds (VOCs) but are minimally reactive with other air contaminants that form ozone. Fumigate only as a last resort when other management strategies have not been successful or are not available.		
C.	**METAM SODIUM***		
	(Vapam HL, Metam CLR 42%)	Label rates	See label
	COMMENTS: For use in sprinkler or furrow-irrigated tomatoes. Apply with enough water to penetrate 18–24 inches and treat at least 50% of planting bed width. Blade injection of metam sodium into preformed beds for weed control gives erratic nematode control; apply with irrigation water for best control of nematodes. Follow recommended waiting period on label before planting to avoid injury to tomato plants. Fumigants such as metam sodium are a source of volatile organic compounds (VOCs) but are minimally reactive with other air contaminants that form ozone. Fumigate only as a last resort when other management strategies have not been successful or are not available.		
PREPLANT and POSTPLANT			
A.	**OXAMYL***		
	(Vydate)	Label rates	48
	COMMENTS: Oxamyl can be applied through drip irrigation lines. Apply before seeding or transplanting; repeated application is needed for continued protection during the growing season.		

**	See label for dilution rates.
‡	Restricted entry interval (REI) is the number of hours (unless otherwise noted) from treatment until the treated area can be safely entered without protective clothing.
*	Permit required from county agricultural commissioner for purchase or use.

UC PEER REVIEWED

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