Major nematodes causing problems on alfalfa in California:

- Stem & Bulb
  - *Ditylenchus dipsaci*

- Root-knot
  - *Meloidogyne sp.*

Alfalfa Stem Nematode:
In group of stem and bulb nematodes because they feed on the above ground portions of the plant (crowns, stems, leaves).

- Infested stems (top 2 rows with shortened internodes)
- Healthy stem

Other symptoms include drying of leaves.
Infestations can be patchy with levees looking better than the rest of the field. May be due to water movement (nematodes spread with water).

Usually only first cutting affected (stem nematodes prefer cool, moist conditions), then stand recovers.

In severely affected fields, stand may never fully recover because feeding by nematodes damages crown, causing crown rot from secondary pathogens such as *Fusarium*.

Alfalfa Stem Nematode

• Found in alfalfa in California prior to 2009, but not causing much damage.

• 2009 first record of widespread significant yield losses followed by successive bad years with increasing damage. Losses primarily in the Sacramento and Northern San Joaquin Valley.

• Estimated losses: Unknown, likely over $50 million/year (yield, quality, stand decline).

What triggered the sudden alfalfa stem nematode outbreaks and why is it more severe in the North vs. South Valley?

**Alfalfa Stem Nematode Biology**

• Optimum temperature: 59-68°F (15-20°C)
• Reproductive range: 41-86°F (5-30°C)
• Most severe in moist, cool weather with first/second cuttings affected
• Generation time: 19-23 days
• 4th juvenile stage desiccation resistant (survival stage)
• Found in both soil and buds

<table>
<thead>
<tr>
<th>SOLANO COUNTY (DIXON)</th>
<th>STEM NEMATODE SOIL (LITER)</th>
<th>STEM NEMATODE BUD (1 INCH)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ROBBEN OLD SHOP</td>
<td>900</td>
<td>66.0</td>
</tr>
<tr>
<td>ROBBEN RR6 OLD S/O SHOP</td>
<td>50</td>
<td>12.0</td>
</tr>
<tr>
<td>RR6 100</td>
<td>100</td>
<td>30.0</td>
</tr>
<tr>
<td>RAYNS SOUTH ARRIBA</td>
<td>50</td>
<td>9.0</td>
</tr>
<tr>
<td>FOXTAIL</td>
<td>100</td>
<td>0.0</td>
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</tbody>
</table>
Outbreaks may be due to a combination of three factors:
1) TEMPERATURE
Average minimum ambient temperatures, 1983-2014 for November to February. CIMIS weather data.

2) DECREASE IN ORGANOPHOSPHATE (OP) AND CARBAMATE USE
Number of acres of alfalfa and OP and carbamate use in alfalfa*. Insecticides suppress nematodes (nerve agents).

3) IRRIGATION MANAGEMENT
Irrigation water spreading nematodes from infected to clean fields

*chlorpyrifos, malathion, carbofuran, phosmet, and methomyl

•Three factors combined (increasing winter minimum temperatures, decrease in OP and carbamate use, and re-use of infected water) contribute to increasing stem nematode populations, overcoming current resistance levels in the alfalfa plant.

•Stem nematode is likely here to stay.
Alfalfa Stem Nematode Management

1) **Crop rotation:**
Rotation with non-host crops such as tomatoes, sunflowers, and wheat on a 2 to 4-year basis will reduce alfalfa stem nematode populations (longer rotations are better).

Control volunteer alfalfa on levees.

Overseeding with grasses is not a rotation, since alfalfa hosts remain in the field.

Alfalfa Stem Nematode Management

2) **Certified seed:**
Growers should always choose to plant certified seed to minimize risks of introducing alfalfa stem nematode as well as other pests, weeds, and diseases in their fields. Stem nematode can survive in 4th juvenile stage which is desiccation resistant.

Stem nematode is not found inside of alfalfa seeds. But they may be in chaff harvested with the seed. Certified seed has been cleaned and tested for nematodes.

Alfalfa Stem Nematode Management

3) **Plant resistant varieties** (Mechanism likely biochemical with nematodes chemically prevented from reproducing in plant)

**Resistance Ratings:**
- 0-5% Susceptible
- 6-14% Low Resistance (LR)
- 15-30% Moderate Resistance (MR)
- 31-50% Resistance (R)
- >50% High Resistance (HR) (considered good for alfalfa)

- Resistance is not immunity, and even the best highly resistant varieties may become infected and develop symptoms under high nematode pressure.

- Plant breeders are currently working on developing varieties showing at least 70% stem nematode resistance.
Alfalfa Stem Nematode Management

4) Water management. Water is reused from stem nematode infected fields may be a major source of infection for healthy fields. Minimize runoff from infected fields and prevent moving this water to non-infected fields when possible.

5) Equipment Sanitation
• Avoid moving contaminated farm machinery from stem nematode infested to clean fields.
• Harvest nematode-free fields before infested fields.
• Clean equipment when moving from a stem nematode infested field to a clean field. This can be done using a high-pressure washer or blower, or by cutting grass hay prior to moving back into alfalfa.

6) Livestock. Uncomposted manure from animals fed stem nematode infested hay may be a source of this pest. Sheep grazing in the alfalfa for winter weed control can also move the stem nematode around fields via tracking dirt on hoofs.

7) Pesticides
Stem nematode trial 2009: Two treatment timings (Winter [early March] and Fall [Mid-November]) in Yolo and Colusa counties.
TREATMENTS

1) Untreated control
2) DiTera: microbial nematicide
3) Cobalt: chlorpyrifos (Lorsban) + pyrethroid
4) Movento: systemic insecticide, spirotetramat
5) Spinetoram: spinosad
6) Agri-Mek: abamectin, miticide/insecticide
7) Vydate: nematicide/insecticide

Materials applied at recommended field rates. Only Cobalt registered for use in alfalfa, others experimental.

Summary

Stem nematode likely will continue to be a significant pest (increasing minimum winter temperatures, reduction in OP and carbamate insecticides, and found in irrigation water).

In stem nematode infested areas, sample fields prior to planting to be sure fields are clean to prevent damage to seedling fields.

Field sprays of various compounds can reduce soil numbers, but not to zero, and in trials to date have not controlled plant-based infection or reduced yield loss.

Crop rotation, variety selection, certified seed, equipment sanitation remain our primary tools for managing stem nematode in alfalfa.