NEMATODE MANAGEMENT IN ALFALFA PRODUCTION

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ABSTRACT

Nematodes are minute roundworms that can infect and feed on alfalfa, causing serious yield, forage quality and stand losses in seedling and established stands. The three most significant nematode pests in alfalfa include the stem nematode, root knot nematode and the lesion nematode. The stem nematode feeds in the stems and crowns of the alfalfa plant, while the root knot and lesion nematodes feed on roots. Currently there are no nematicides registered for use in alfalfa that control nematode pests. As a result, growers must rely on cultural practices such as the use of certified seed, crop rotation and equipment sanitation as well as the use of resistant plant varieties to manage plant parasitic nematodes in alfalfa production. Fumigation before planting may be too costly relative to potential economic benefits.

Key Words: Alfalfa, nematodes, integrated pest management

INTRODUCTION

Plant-parasitic nematodes are microscopic roundworms that live in soil and plant tissues, and feed on plants by puncturing and sucking the cell contents with a needlelike mouthpart called a stylet. The most significant nematode pests in alfalfa that can cause yield and quality losses as well as stand decline include the stem nematode, several species of root knot nematodes and lesion nematode (Table 1). The alfalfa stem nematode feeds in the stems and crowns of the alfalfa plant, while the other nematodes feed on roots. The nematode life cycle typically includes an egg stage, four larval stages and an adult stage.

The complete nematode life cycle from egg hatch to adult to egg production usually requires 3 to 6 weeks under optimal conditions. Environmental factors, such as soil temperature, soil moisture, host status, time of infection, alfalfa variety and initial nematode numbers at time of planting can influence the number of nematode generations completed within a year. Nematodes move relatively short distances on their own (a few inches per year), but they are easily spread long distances by soil movement via wind, farm equipment or irrigation water, nursery stock, and seed contaminated with alfalfa chaff.

There are no registered nematicides in alfalfa for control of nematode pests. Current recommendations for nematode management in alfalfa production include the use of cultural practices, such as the use of certified seed, field knowledge history, crop rotation and equipment sanitation, as well as the use of resistant plant varieties. Fumigation before planting alfalfa stands is possible, but may be too costly relative to potential economic benefits.

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Monitoring and identifying the nematodes present in the field, through sampling soil and plant tissue, is vital for developing management recommendations for control of this pest in alfalfa as other abiotic and biotic factors (disease/insect) may cause similar damage.

How to sample:

1. Divide the field into sampling blocks of not more than twenty acres each that represent cropping history, crop injury, or soil texture.
2. Take several subsamples randomly from a block, mix them thoroughly, and make a composite sample of about 1 quart (1 liter) for each block.
    a. If symptoms of stem nematode are evident, such as stunted growth and open patches in the field, cut several stems with symptoms from several different plants.
    b. If root-feeding nematodes are suspected, take soil samples from within the root zone (6 to 18 inches deep).
3. Place the samples in separate plastic bags, seal them, and place a label on the outside with your name, address, location, the current and previous crop, and the crop you intend to grow.
4. Keep samples cool (do not freeze), and transport as soon as possible to a diagnostic laboratory. Stem nematode is easily identifiable under a dissecting scope. Cut alfalfa stems into half inch pieces into a Petri dish using scissors or a razor blade. Add water until the alfalfa plant pieces are submerged. Let sit for 15 minutes. Look for large, clear worms that appear to be swimming.

ALFALFA STEM NEMATODE

Alfalfa stem nematodes are highly specific to alfalfa, and most prevalent in fields during late winter (February-March) when cooler temperatures favor development (optimum 59-68^{o}F). This pest is increasing in severity, particularly in the Sacramento Valley. What triggered recent stem nematode outbreaks is unknown, but may be due to an interaction of several factors. First, it is possible that increasing wintertime temperatures with a recorded 46% less fog than 30-years ago is favoring stem nematode outbreaks (Baldocchi and Waller 2014). Secondly, organophosphate and carbamate use in alfalfa has declined by 50% since 2005 (Figure 1). These classes of pesticides, which can suppress stem nematodes, have primarily been replaced by pyrethroids, which do not affect this pest.

Stem nematodes are present in the crown, enter bud tissue, and migrate into developing buds. Infected stemsbecome enlarged and discolored, nodes swell, and internodes become shorter than those on healthy plants. Infected alfalfa plants will have stunted growth, fewer shoots and deformed buds.

Stem nematode infested fields may also display ’white flags’, whereby individual alfalfa stems and leaves turn white, especially during summer months. White flags occur when nematodes move into leaf tissue and destroy chloroplasts, leaving pale leaf tissue. Stem nematode feeding can also injure the alfalfa crowns, creating entry wounds for fungal and bacterial pathogens (such as *Phytophthora* or *Fusariaum* wilt) that cause crown rot, reduced yields, and stand losses. As alfalfa plant dieback occurs, weeds often invade the open areas.

Management. Crop rotation is very important in helping to control alfalfa stem nematode since alfalfa is the primary host (though potatoes and Sainfoin may also be infected by this pest). Consequently, rotation with non-host crops such as tomatoes, small grains, beans, and corn on a 2- to 4-year basis should reduce alfalfa stem nematode populations (longer is better for heavily infested fields). Overseeding older alfalfa stands with grasses is not a rotation, since alfalfa hosts remain in the field. Control volunteer alfalfa plants in subsequent crop rotations and on levees.

For areas with stem nematode, plant highly resistant varieties to help prevent yield and stand losses. Germplasm screening is ongoing to develop alfalfa varieties with >70% resistance to stem nematodes (current levels are mostly >50%). For more information on current nematode-resistant varieties, seethe National Alfalfa & Forage Allianceat (http://alfalfa.org/pdf/Alfalfa%20variety%20leaflet.pdf).

Use certified clean, nematode-free seed. Stem nematode is not seed borne, but can live on alfalfa chaff. Certified seed is well cleaned to remove alfalfa debris. and stem nematodes, and then tested for the presence of stem nematode before seed sales.

Avoid moving contaminated farm machinery or livestock from an infested field to a clean field. Avoid using contaminated wastewater or tail water. Keep manure from feedlots where cattle have been fed infected hay out of clean 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.

No nematicides are currently registered for use against the alfalfa stem nematode in established alfalfa fields that control the nematode in the plant, though several have been investigated. In a Yolo County trial in 2009, pesticides applied during late winter showed some nematode reductions in the soil, Figure 2. However, in both Colusa and Yolo County trials, these pesticides did not control the nematodes in the plants nor did they enhance alfalfa yields. Fall treatments likewise did not show efficacy against nematodes. As a result, pesticides are not recommended for alfalfa stem nematode control at this time.

ROOT-KNOT NEMATODES

There are a number of *Meloidogyne,* root-knot nematode, species that infect alfalfa (Table 1). The northern root knot nematode (*M. hapla*) infects and parasitizes roots of alfalfa plants and causes the plant cells to enlarge into small oval galls on the roots that can be seen with the naked eye. The root galls produced by these nematodes may be confused with the beneficial nitrogen-fixing bacteria that form nodules on roots. However, the nematode galls are hard while the nitrogen fixing nodules are soft and fleshy. Seedlings fields may be killed in heavily infested stands, even though roots may not display galls.

The Columbia root knot nematode (*M. chitwoodi*) produces symptoms similar to the northern root knot nematode, but it is less pathogenic to alfalfa. This nematode causes tiny galls that can easily be missed if roots are not examined carefully.

Root knot nematodes, like stem nematodes, may enhance the development of diseases such as bacterial wilt, *Phytophthora* root rot, and *Fusarium* wilt. In addition, damage by the alfalfa stem nematode may be more severe when the northern root knot nematode is also present.

Management. The use of resistant alfalfa varieties is probably the most practical means of managing root knot nematodes. There are a number of different alfalfa varieties that are now commercially available for the northern and southern root knot nematodes. Unlike other crops such as tomatoes, resistant varieties of alfalfa do not help reduce nematode populations because there will always be some alfalfa plants in the field that have no resistance to root knot nematodes, based on alfalfa resistant ratings.

Depending on the root knot nematode species present in the field, crop rotation can be a useful management strategy. It is important to have the species identified. For *Meloidogyne incognita,* the following are good rotation crops: barley, oats, wheat, cole crops, corn, cotton, hops, sudangrass, and cowpea. For *M. hapla*, cotton serves as a good rotation crop.

ROOT LESION NEMATODES

Plants infected with root lesion nematodes exhibit aboveground symptoms such as stunting and nutrient deficiencies. Impact on the root system includes reduced root growth and black or brown lesions on the root surface. Lesions may fuse to cause the entire roots to appear brown. Secondary infections of roots by bacterial and fungal pathogens commonly occur with a root lesion nematode infestation; feeding by root lesion nematodes may overcome the resistance of the alfalfa varieties to these pathogens. Damage caused by lesion nematode depends on the alfalfa variety and the species of lesion nematode present in the field. Under severe infestation, young plants often die, resulting in yield reductions.

Management. Lesion nematodes have a very wide host range, and more than one species may occur in a field, making crop rotation ineffective for lesion nematode management. Leaving a field fallow and weed free can reduce lesion nematode numbers, but not enough to prevent crop damage to new alfalfa plantings. If lesion nematodes are present in the field, it is important to maintain good plant health. Plants that are stressed (for example from too little water) will be more susceptible to lesion nematode damage.
Screening is ongoing to identify alfalfa germplasm with resistance to lesion nematodes, but currently there are no commercially certified varieties with lesion nematode resistance.

CONCLUSION

It is critical to know the nematode species present and the density of their populations to make management decisions. If a previous field or crop had problems caused by nematodes that are listed as pests of alfalfa, numbers may be high enough to cause damage to seedlings. If nematode species have not previously been identified, take soil samples and send them to a diagnostic laboratory for identification.

LITERATURE CITED

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Table 1. Plant parasitic nematodes that can infect alfalfa, potentially causing yield and quality losses and stand decline.

Alfalfa Stem Nematode
Stem nematode, *Ditylenchus dipsaci*
Root Knot Nematodes
Northern root-knot nematode, *Meloidogyne hapla*
Southern or cotton root-knot nematode, *M. incognita*
Javanese root-knot nematode, *M. javanica*
Thames' root-knot nematode, *M. thamesi*
Peanut root-knot nematode, *M. arenaria*
Columbia root-knot nematode, *M. chitwoodi*
Lesion Nematode
Cobb's meadow nematode, *Pratylenchus penetrans*
California meadow nematode, *P. neglectus*

Figure 1. Number of acres of alfalfa and organophosphate and carbamate use in this crop (known to have efficacy against stem nematode). Pesticides include chlorpyrifos, malathion, carbofuran, phosmet, and methomyl. California DPR statistics, 2005-12.

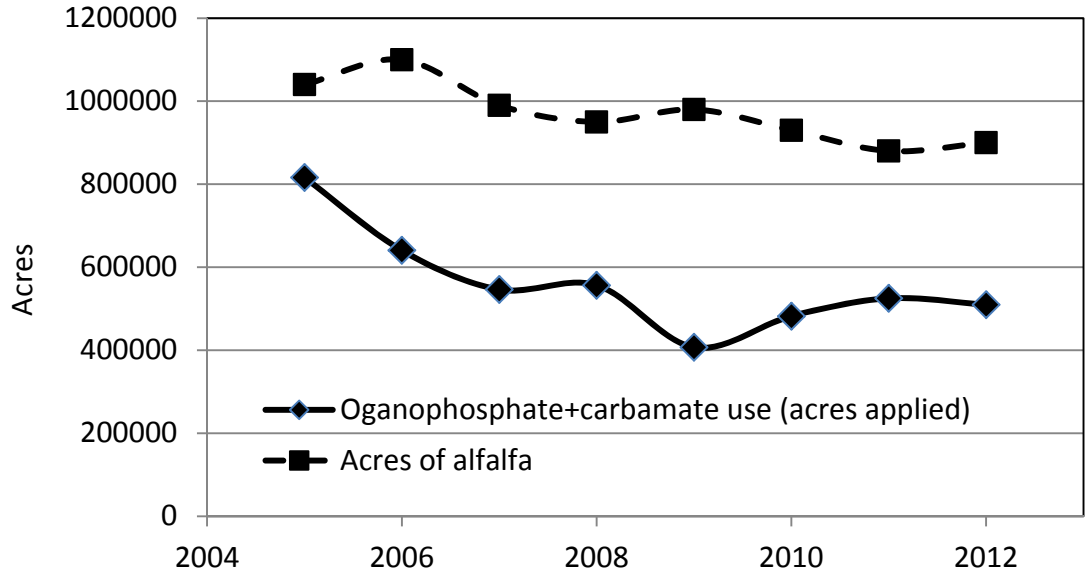

Figure 2. Number of stem nematodes per liter of soil, Yolo County, 2009. Plots treated March 13 and sampled April 23, 2009. **All pesticides listed in the chart below are unregistered for use in alfalfa except Cobalt (chlorpyrifos+pyrethroid).**