NEMATODES OF ALFALFA

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These parasites can reduce stands and also allow disease organisms, such as bacterial wilt and fusarium wilt, to attack the alfalfa plants through the lesions they cause. Resistant varieties and crop rotation are helpful.

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WHILE NEMATODES are not usually a serious pest in alfalfa seed production, they can cause substantial losses to stands and thus lower production, under certain conditions. The northern root-knot nematode (*Meloidogyne hapla*) and the stem nematode (*Ditylenchus dipsaci*) are the most important nematode pests of alfalfa in the Pacific Northwest. Limited studies suggest that root-lesion nematodes (*Pratylenchus penetrans*) may also affect production. Nematodes can adversely affect emergence and establishment of young seedlings and also permit other organisms to attack the plants.

ROOT-KNOT NEMATODES

Four species of root-knot nematodes are important on alfalfa, but only *M. hapla*, the northern root-knot nematode, is a problem on alfalfa in the Pacific Northwest. Although found in many soils, root-knot nematodes thrive best in moist sandy loam soils. They live as parasites in the root tissue of alfalfa and a number of other hosts. Small oval galls develop and excessive branching occurs on the roots of alfalfa at the site where this nematode feeds (Fig. 1). The galls sometimes resemble nitrogen-fixing nodules but can be distinguished since healthy nodules are characteristically pink. Severe stand and vigor reduction can result from heavy infestations.

In 1978, a new root-knot nematode species was discovered in the Pacific Northwest. It was named *M. chitwoodi*, the Columbia root-knot nematode. Early tests indicated that alfalfa was a poor to nonhost of this new species. During 1982, how-

FIG. 1—Root-knot nematode symptoms in alfalfa feeder roots, showing knots and proliferation of small roots.

ever, several Washington potato fields rotated with alfalfa (variety unknown) were damaged by *M. chitwoodi*. This suggested the nematode was feeding and reproducing in sufficiently high numbers on alfalfa to be a threat to a succeeding host crop. The unknown alfalfa variety may have been a good host for *M. chitwoodi* or, as often happens with other pests, a race of *M. chitwoodi* existed which was able to reproduce on alfalfa. Subsequent greenhouse studies in 1983 with two *M. chitwoodi* populations isolated from these alfalfa-potato rotations resulted in moderate infections on nine alfalfa varieties. This would strongly suggest there are *M. chitwoodi* populations which can feed and reproduce on alfalfa and must be considered in a crop rotation scheme. Studies are continuing to evaluate the role of alfalfa in harboring this pest.

Root-knot nematodes may build up to large numbers in established stands and plants may be stunted. More importantly, nematode injury may provide easier entry and increased reaction for other alfalfa pathogens. The northern root-knot nematode increases bacterial wilt infection in both resistant and susceptible varieties.

Disease Cycle

The adult female feeds inside the root but deposits her eggs on the alfalfa root surface. When temperature and soil moisture are favorable, the eggs hatch and the new juveniles migrate into the soil or to nearby plant roots. They invade the plant near the root tip and usually feed with their heads permanently buried in the plant tissue. This results in a disruption of the vascular cylinder and interferes with cell development. Adjoining cells enlarge and coalesce to form giant cells that become a continual food source for the nematode. The nematode derives its common name from this root swelling or galling which resembles knots on the roots. Female juveniles rapidly increase in size and become pear-shaped as they near maturity. Each female then deposits from 400–800 eggs in a protective gelatinous mass on the surface of the root. The life cycle of *M. hapla* on alfalfa takes approximately 28–30 days at 75–80°F. Soil temperatures below 60°F. are practically prohibitive to *M. hapla* root invasion and development. Conversely, *M. chitwoodi* can invade host roots and develop at temperatures as low as 45–50°F. Because low *M. chitwoodi* populations can invade roots early in the season and reproduce at lower temperatures than *M. hapla*, more nematode generations may develop during the growing season.

Control

Resistant varieties are the most practical method of combating this nematode. There are no commercially available varieties adapted to the Northwest with complete resistance; however, two germplasm sources (Nevada Syn XX and Nevada Syn YY) have been released for plant breeders to use in developing new varieties. Crop rotation with cereals is recommended if it is known that *M. hapla* is the species in the field. The Columbia root-knot nematode, *M. chitwoodi*, will readily attack cereals and corn. Weed control in nonhost crops is important since many common weeds are hosts to the nematode.

ALFALFA STEM NEMATODE

The alfalfa stem nematode, *Ditylenchus dipsaci*, is a destructive pest primarily in irrigated regions of the United States or areas of high rainfall but may occur occasionally in other areas. The wide distribution of the stem nematode is probably due to its ability to survive in dry plant debris which may have been shipped in poorly cleaned seed lots.

This nematode hatches from eggs and goes through four stages or "molts," any of which can infect the plant. The nematodes congregate under the developing leaflets, at or near the soil surface, and penetrate the young succulent stem or bud tissue (Fig. 2). The nematode derives its name from this tendency to feed in stem tissues instead of the roots. Usually the base of an infected stem becomes swollen, discolored, and roughened. This plant cell disruption causes swollen nodes and shortened internodes (Fig. 3). Cool, damp weather is most favorable for stem nematodes since the

FIG. 2—Effect of stem nematode on established alfalfa. Left to right: Swollen buds and dead root section; normal plant; swollen, blackened buds and "white flagging;" swollen buds and dying crown.

FIG. 3—Swollen cotyledonary node, as a result of the alfalfa stem nematode, on seedling alfalfa.

alfalfa grows slowly but is very succulent. During warm weather the alfalfa stems elongate more rapidly and appear normal. Invasion by nematodes kills cells along the stems and down into the crown. Infected stems may blacken and are easily broken off. Examination of crushed infected stems or buds under a microscope reveals hundreds of nematodes in all stages of development from eggs to adults.

The number of stems per crown is reduced as the alfalfa crown is damaged. With severe infestations, the nematodes may migrate into leaf tissue causing leaf curling and distortion. The nematode infection causes a condition known as "white flagging." Some affected shoots, particularly regrowth after the first cutting, may lack all green color and appear as completely white leaves on scattered plants in a field. Midsummer populations of the nematode are usually quite low due to high temperatures.

Distribution in irrigation water, in hay, and by debris in seed has been the primary means of spreading the nematode. Modern seed cleaning equipment has aided measurably in reducing the spread of nematodes in seed.

Disease Cycle

The alfalfa stem nematode is usually specific to alfalfa and does not readily transfer to other hosts. Nematodes in all stages of development are abundant in spring and fall but can be found throughout the growing season. Eggs are laid in infected plant tissue. Juveniles grow rapidly to the preadult, which is the most infective, stage. Preadult nematodes are able to withstand drying over long periods of time. Optimum temperature for invasion and reproduction in alfalfa is 60–68°F., and the life cycle can be completed in 19–23 days. Reproduction can occur from 40–95°F.

Preadults overwinter in the soil, in crop debris, and in the alfalfa crown. In cool, moist climates or early spring, nematodes move in a film of moisture to directly invade the buds. A film of moisture provides the only way for the nematodes to move about and work their way into the buds. Infestations are markedly reduced during dry, windy, or hot periods.

Control

Resistant varieties are the most practical means of control. Varieties such as Washoe and Lahontan are recommended in areas where they are adapted. Several privately developed varieties have moderate levels of resistance.

Crop rotation with grains, beans, or sugarbeets will reduce populations. However, reinfestation can occur in a short time when susceptible varieties are used, or through harvesting machinery, irrigation water, and use of waste water.

Burning is generally not recommended though fall burning of a field will decrease but not eliminate the nematode population. Spring burning may result in increased infection due to earlier initiation of bud growth and warmer soil temperatures.

Soil fumigants are not economically feasible when alfalfa is grown for hay production. However, when it is grown for seed, preplant soil fumigation would be feasible where severe nematode problems have been encountered.

Fallow is not a good control since the preadult stage of this nematode can survive many months under dry conditions.

ROOT-LESION NEMATODES

Seven species of root-lesion nematodes, *Pratylenchus* spp., attack alfalfa; of these, *P. penetrans* is most important. Root-lesion nematodes are migratory endoparasites; they move in the root system and damage and destroy plant cells during migration and feeding. Studies show that control of root-lesion nematodes, especially *P. penetrans*, in seedling alfalfa results in increased yields the first year. Root-lesion nematodes also decrease cold tolerance and increase infections by *Fusarium* spp.

High numbers of nematodes on alfalfa plants cause some reduction in growth. Damage is difficult to assess since there is no readily apparent symptom on the above-ground parts of the plant.

Disease Cycle

Pratylenchus adult females lay eggs in infected root tissue or in the soil. Juvenile and adult nematodes enter roots by penetrating between and through cells on the root surface. Lesions are formed at the point of entrance on the root, hence the name root-lesion nematode. Lesions usually turn dark, and several may coalesce to give roots an overall brown appearance. Heavy infestations cause a reduction in root development. Root penetration occurs from 40–95°F., with maximum frequency of penetration between 50 and 85°F. The life cycle generally will be completed in 28–30 days, but environmental factors may slow this rate.

Control

No resistant alfalfa varieties are presently available, and little is known concerning the long-term performance of varieties to this nematode in the Northwest.

Preplant chemical treatments may be of value if it is known this nematode has been a problem in the previous crop. Generally chemical treatment of alfalfa for control of this nematode would not be economical.

OTHER NEMATODES

At least 15 other plant parasitic nematodes are reported to be associated with alfalfa but have not been shown to be a problem in the Northwest.