

NEMATODES IN ALFALFA PRODUCTION

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An article in the Bee newspapers last month (November, 1976), on the subject of field traffic and soil compaction, made the two points that a healthy root system is necessary for good growth of plants and that wheel traffic in the fields causes soil compaction and restricted root development. I'd like to suggest that there can be several causes for restricted root systems. Certainly soil compaction or a heavy, poorly drained soil are among the most important. However, we must also consider soil pathogens which prune back or otherwise modify the root system so that it becomes less effective in picking up both the water and nutrients which are actually available. These organisms become even more important when they further reduce a root system already restricted by natural or man-caused soil compaction.

I'm here to discuss plant parasitic nematodes, and I'll leave other soil pathogens to other speakers. First, what do we know about nematodes on alfalfa?

We separate the soil-infesting plant parasitic nematodes into two types, based on how they feed and reproduce. One type is endoparasitic. These enter roots, usually the small feeder rootlets, and both feed and deposit eggs inside the root tissue. The effects of their feeding is a destruction of cells or a change in structure and function of cells. In either case the root system does not develop normally beyond the infection site. The other type of plant parasitic nematode is the ectoparasite. These forms live, feed and reproduce in the soil outside the roots. Most of these nematodes are large compared to the first type and have a much larger feeding apparatus (spear) relative to body size. They remain in the soil at the rootlet surface and insert their long spears into the root. This kind of feeding also may kill cells but there are indications that enzymes secreted by some forms also can cause cellular changes which malform the roots and interrupt growth and function.

Some crops are attacked by only one or two soil-infesting nematodes. Unfortunately alfalfa seems to be a favored host of a variety of nematodes. Let's list those we know in California and then discuss them in more detail.

Endoparasites

Root knot nematodes

Meloidogyne hapla -- Northern root knot nema
M. incognita -- Cotton root knot nema
M. javanica -- Javanese root knot nema
M. thamesi -- Thame's root knot nema

Root lesion nematodes

Pratylenchus neglectus
P. spp.

Ectoparasites

Dagger nematodes

Xiphinema americanum - American dagger nema

Ring nematodes

Criconemoides curvatus
C. spp.

Stunt nematodes:

Tylenchorhynchus clarus

Stubby root nematodes:

Trichodorus spp.

Spiral nematodes:

Helicotylenchus spp.

It is significant in scanning this somewhat lengthy list that, although we have recorded these nematodes from alfalfa, most studies have been directed toward alfalfa as a rotational crop. The nematodes which might increase on alfalfa and reduce production of other crops were the objectives. For example, cotton/alfalfa rotations in early cotton investigations were found to be successful in reducing injury to cotton when the root knot nematode present was M. javanica. This nema does not attack cotton. Rotations were not effective when the nema was found to be M. incognita, the only injurious root knot nema on this crop.

Now we have begun to direct our attention to alfalfa production itself, and we find ourselves lacking a great deal of information which is going to take years of careful greenhouse and field investigations to produce.

The root knot nematodes are proven pathogens of alfalfa and are the most common species found on this crop. These nematodes express their effect most severely in coarse sandy soils, those often referred to as "marginal" alfalfa soils. Swelling or galls develop on the roots inhibiting root elongation. If large numbers are present new plantings may never become established. Stand life is reduced when lower numbers are present initially and increase on the alfalfa roots. Restriction of root systems may result in deficiency symptoms, such as potassium deficiency, even though the soil contains an adequate amount.

Recent work (Noel, 1976) has demonstrated that the ring nematode, Cricone-moides curvatus, can significantly reduce both root and top growth of alfalfa under greenhouse conditions. Similar work at Davis suggests that the stunt nematode, Tylenchorhynchus clarus, causes a similar effect. Field observations suggest that dagger, stubby root and spiral nematodes increase in numbers on alfalfa and are associated with unthrifty stands.

Another nematode which injures alfalfa does not infest the roots but instead attacks the crowns and developing shoots. This is the alfalfa stem nematode, Ditylenchus dipsaci. The alfalfa stem nematode is one of the biotypes or strains of D. dipsaci. Other biotypes are present in California as pests of such diverse crops as bulbs (onion, garlic, narcissus) and ornamentals such as phlox, primrose, aster and hydrangea.

On alfalfa, D. dipsaci seems to have become a pest in California only in the cool coastal area on non-dormant alfalfas and in widely scattered mountain areas on dormant types. It has never become wide-spread in the lower inland valleys. Populations in plants increase rapidly in late winter and early spring, stunting or killing new growth. Infested shoots are tender and easily killed by frost or drying winds. This nematode is very resistant to desiccation and can be revived from infested hay. Spread to new localities occurs readily by distribution in hay.

Control

Control of soil-borne plant parasitic nematodes probably will rely eventually on the development and use of resistant or immune varieties. The recent work and release of germ plasm resistant to root knot nematodes by Dr. Joe Hunt and associates has been a significant step in this direction. Resistant to the alfalfa

stem nematode continues to be acceptable in most situations with Lahontan and its derivatives. Chemical control investigations will not be abandoned, but recent developments suggest that we probably should not rely on such methods.

First, the price of alfalfa hay will not support a soil or plant treatment except under unusual circumstances. Soil fumigation has never been cheap. An experimental preplant soil treatment reported in 1963 (Eide and Gregory) with 20 gallons per acre of 1,3-D fumigant (Shell DD) cost \$53.00 per acre and gave a net profit over three years of \$15.00 per acre. This treatment gave significantly increased yield only the first year. In my judgement this rate of fumigant was much too low and probably should have been 40-60 gpa for this kind of crop. The price of this type of soil fumigant is now two to four times as expensive as in 1963 because they originate in the petrochemical industry. There seems little chance that soil fumigation will play an important part in alfalfa production with the chemicals presently available.

In recent years a number of non-fumigant contact and systemic nematicide/insecticides have become available. Some of these have been demonstrated to control root knot and root lesion nematodes in other crops and stem nematode in alfalfa. Most of those chemicals which have "systemic" action move readily upward in the plant from soil applications and root absorption. Only one has demonstrated downward movement from the foliage to the roots, and results with this material have been erratic and unpredictable. In some situations where treatment rates can be adjusted high enough to give adequate nematode control and satisfactory insect control is obtained, the contact/systemics may be promising and economical to use.

In today's climate of review and restriction of pesticides it seems unlikely that the contact/systemic chemicals will gain a place easily in nematode control on alfalfa, except perhaps for stem nematode. Rates for nematode control usually must be higher than for insect control, and resultant residues probably would be unacceptable. One other factor is important here, the cost of obtaining adequate residue information. One chemical producer reported recently that residues in alfalfa hay of 0.06-2.3 ppm were too high for approval in their judgement. They were therefore dropping registration on seed alfalfa and any further attempt to obtain registration for hay because of the high and unpredictable costs of the feeding studies which would be necessary.

In conclusion, we know that certain soil and root-infesting nematodes, as well as the alfalfa stem nematode, injure alfalfa and reduce both productivity and stand duration. Effective control by chemical means appears unlikely in the present climate of low alfalfa prices, high chemical prices and the present official disapproval of even negligible residues. Resistant and immune varieties should provide a better and longer lasting means of control; however, such varieties are limited, take a long time to develop and are not resistant to all nematodes.