Dìtylenchus dipsaci

Introduction

According to present knowledge, *Ditylenchus dipsaci* (Kuhn), the stem and bulb nematodes must be considered to be a species complex or a superspecies composed of a great number of races and populations differing mainly in host preference, and many of them at different stages of speciation and partially or completely reproductively isolated from each other. *D. dipsaci*, is one of the most devastating plant-parasitic nematodes, especially in temperate regions, attacking well over 450 different plant species. However, it occurs in several biological "races" some of which have a limited host range.
The nematode is an important pest in most European countries.

Identity

Authority : (Kuhn) Filipjev
Classification
Kingdom : Animalia
Phylum : Nemata
Class : Secernentea
Order : Tylenchida
Family : Anguinidae
Genus : *Dìtylenchus*
Species : *dipsaci*
Synonyms : *Anguillula dipsaci* Kuhn, 1857; *Anguillulina dipsaci* (Kuhn,1857) Gervais & van Beneden, 1859; *Typlenchus dipsaci* (Kuhn, 1857) Bastian, 1865; *Anguillulina dipsaci var*. allocotus Steiner,1934; *Ditylenchus allocotus* (Steiner, 1934) Filip. & Sch. Stek., 1941; *Anguillulina dipsaci* var. *amsinckiae* Steiner & Scott, 1935; *Ditylenchus amsinckiae* (Steiner & Scott, 1935) Filip. & Sch. Stek., 1941; *Anguillulina dipsaci* var. *communis* Steiner & Scott, 1935; *Ditylenchus dipsaci* var. *tobaensis* Schneider, 1937; *D. tobaensis* (Schneider, 1937) Kirjanova, 1951; *Anguillula secalis* (Nitschke, 1868) Goodey, 1932; *Anguillula devastatrix* Kuhn, 1869; *Tylenchus devastatrix* (Kuhn, 1869) Orley, 1880; *Anguillulina devastatrix* (Kuhn, 1869) Nevue-Lemaire, 1913; *Tylenchus putrefaciens* Kuhn, 1879; *Anguillulina putrefaciens* (Kuhn, 1879) Braun, 1895; *Tylenchus havensteinii* Kuhn, 1881; *Auguillulina havensteinii* (Kuhn, 1881) Goodey, 1932; *Tylenchus hyacinthi* Prillieux, 1881; *Anguillulina hyacinthi* (Prillieux, 881) Goodey, 1932; *Tylenchus allii* Beijerinck, 1883; *Ditylenchus allii* (Beijerinck, 1883) Filip. & Sch. Stek., 1941; *D. fragariae* Kirjanova, 1951; *D. phloxidis* Kirjanova, 1951; *D. sonchophila* Kirjanova, 1958; *D. trifolii* Skarbilovich, 1958.
Common names : Stem and bulb nematode; bud and stem nematode; bulb nematode; clover stem nematode; onion stem nematode; phlox stem nematode; stem nematode; teasel nematode; tulip root nematode.

Signs & Symptoms

Infested plants are generally stunted, malformed, and may eventually die (Fig. 1). Stems are mostly swollen, internodes may be shortened and distorted, gall-like swellings, discolouration, and local lesions can develop. Leaves are often distorted, discoloured and smaller than normal. Stems may also be reduced and misshapen. In many plant species, galls or necrotic spots may develop. In cereals, extra tillers are produced at the base of swollen stems. Inflorescences are malformed in certain hosts (e.g., teasel) and infested seeds, where the nematodes are mostly under the testa or in any debris or persistent tissues surrounding the seed, is produced in field beans, vetches, peas, clover, lucerne, spurrey, onion and other *Allium* spp., teasel, red beet, carrot, buckwheat, and some composits. Severe crown rot develops (fig. 2), e.g., in mature beet, parsley, and carrot plants; in celeraic, decay starts from the lower part of the tap roots and proceeds to the crown. Rotting and decaying of host tissue in association with fungi and bacteria is also common in onions, flower bulbs, rhubarb, and potatoes.

Stem nematodes often invade nonhosts; feeding, further development, and even oviposition may occur but no reproduction takes place. Symptoms produced in nonhost or resistant plants are mostly necroses, and swelling of the stem is often lacking. On heavy invasion even mortality of nonhosts can occur.

Associations of *D. dispsaci* with some pathogenic bacteria and fungi are known. The incidence of bacterial wilt cause by *Corynebacterium insidiosum* on lucerne is increased by *D. dipsaci* infection, and the resistance of some lucerne varieties to wilt is broken by *D. dipsaci* acting as a vector. Damage by *D. dipsaci* increased susceptibility of potato plants to infection by *Phoma solanicola*.

Morphology

Female: Body straight or almost so when relaxed. Cuticle marked by transverse striae about 1 μ apart; lateral fields with four incisures occupying $1/6^{th}$ to $1/8^{th}$ of body width. Lip region low, unstriated, slightly flattened, barely set off from the body. Head skeleton moderately developed, spear about 10-12 μ long with distinct basal knobs. Procorpus of oesophagus cylindrical, narrowing slightly as it joins the fusiform median bulb. Isthmus narrow, surrounded by nerve ring where it begins to expand into a clavate posterior oesophageal bulb that butts onto or slightly overlaps the intestine, a small valve being present at their junction. Excretory pore opposite the basal bulb. Tail conoid, four to five anal-body-widths long with a sharply pointed terminus. Vulva distinct, anterior ovary outstretched with oocytes usually in a single, occasionally double, row that sometimes reaches the oesophageal region. Post-vulval sac present, extending about halfway to the anus.

Male: Anterior region similar to female. Body almost straight when killed by heat. Tail similar to female with sharply pointed terminus; bursa present that begins opposite the anterior end of the spicules and extends about $3/4^{th}$ of the tail length. Spicules curled ventrally and expanded anteriorly; gubernaculum short, simple.

Biology & Ecology

D. dipsaci is an obligate plant-parasitic nematode which feeds on the tissues of higher plants, but a Californian population from garlic was reported to reproduce to some extent on soil fungi such as *Verticillium* or *Cladosporium.* A migratory endoparasite, the stem nematode feeds in parenchymatous tissues of stems, but it is also found in foliage, in inflorescences, buds, rhizomes, and stolons; roots are rarely invaded. Usually, young growing tissues are invaded, especially seedlings while below the soil surface, or the nematodes migrate to the apical regions of developing or developed shoots. They enter plant tissues through stomata, or penetrate directly at the base of stems and leaf axils. Feeding causes breakdown of middle lamellae; the nematodes probably secrete a pectinase enzyme. Plant parts become "crisp", and are easily broken. All stages of development outside the egg are capable of infecting plants, but the fourth-stage juvenile is the most important infective stage, due to its outstanding ability to withstand desiccation and to undergo anabiosis during which numerous individuals form clumps of "eelworm wool" on or below the surface of plant tissues, or become attached to seeds. Mating, which is necessary for reproduction, deposition of eggs, and development take place within plant tissues. Females lay between 200 and 500 eggs each and live for 45-73 days. Temperatures of 15, 16, 19 and 20- 25C have been reported as optimum for development and reproduction. Maximum activity and highest invasion ability is generally between 10 and 20C. Cool, moist, conditions favour invasions of plants by this nematode which was found to migrate to the soil surface after rains. Migration on above-ground plant parts requires free water and will occur after rain or overhead irrigation. This nematode is known to be a good "swimmer". Under dry conditions, plants may outgrow *D. dipsaci* invasion.

The soil type appears of major importance in the persistence of stem nematodes; populations survived in clay soils but rapidly declined in sandy soils. Populations of "oat race" and "giant race" survived at least 8-10 years in the soil without weed or crop host plants.

Dispersal /vectors

The present cosmopolitan distribution of *D. dipsaci* is partly a result of man's activities, and dissemination has been much facilitated by the ability of the nematode to survive desiccation. Flower bulbs, phlox, strawberry, and other perennials, and nursery stock have been important distributing agents. In addition, seeds of lucerne, clover, field beans, onions, and other plants, as well as garlic cloves have been among the common carriers. *D. dipsaci* is also readily dispersed through wind, water, and implements.

Management

Cultural Control

Dissemination of *D. dipsaci* through seeds, bulbs, rhizomes, garlic cloves, or any other infested planting material, or straw, hay or any debris of the host as well as through irrigation water, farm machinery, etc., should be avoided

For the most part, rotation with nonhost crops for three or four years will drastically decrease soil populations of *D. dipsaci*, but special attention should be given to weeds as possible reservoir hosts and sources of infection. Under nonhost crops, *D. dipsaci* races with a wide range, including many weeds, appear to persist almost indefinitely in heavy soils. Damaging attacks of stem nematodes can be avoided when a biological race is identified, or the host range of the particular population is known.

The use of resistant varieties is usually the most efficient method of controlling *D. dipsaci*, and in certain crops, probably the only economic method. Stem nematode-resistant varieties have been selected or bred in lucerne, red clover, white clover, oat, rye, and other cultivated plants; differences in susceptibility were also recorded for maize, field beans, onion, and garlic.

Chemical Control

Hot water treatment, sometimes combined with soaking in nematicides, was commonly used to disinfect dormant flower bulbs, onions, garlic, and strawberry runners and methyl bromide to fumigate infested seed. Such control measures decreased drastically the population density or the infestation rate, but almost never eliminated stem nematodes.

Soil fumigation to control stem nematodes is usually not economical. Seed furrow applications and row treatments to protect seedlings and application of systemic nematicides were effective. Nematicides incorporated in pelleted seeds showed promising control effects. Significant control of *D. dipsaci* was obtained by soil solarization. Flooding of soil for one month was also effective.

Biological Control

The fungus, *Hirsutella rhossiliensis*, appears to be a promising agent for biological control of stem nematodes. Several other fungi were found attacking *D. dipsaci*.

Host Notes

The nematode is an important pest in most European countries. Teasel, the type host, is a biennial plant grown on a limited scale in Europe and the USA. The "stem and bulb eelworm" causes much damage wherever daffodil and narcissus (*Narcissus pseudonarcissus*), and to some extent tulip (*Tulipa gesneriana*) and hyacinth (*Hyacinthus orientalis*) are grown. Vegetable crops severely attacked include onions (*Allium cepa*), garlic (*A. sativum*) and to some extent, leeks (*A. porrum*), shallots (*A. ascalonicum*), carrots (*Daucus carota*), and peas (*Pisum sativum*). Root crops readily attacked, especially in Europe, include potatoes (*Solanum tuberosum*), sugarbeet, fodder beet and mangel (*Beta vulgaris* ssp. *vulgaris*), swede (*Brassica napus*) and turnip (*B. rapa*). Rye (*Secale cereale*) and oats (*Avena sativa*) have frequently been reported to be severely damaged in Europe, and in the USA; maize (*Zea mays*) is another cereal sometimes affected in Europe. Of leguminous crops, attacks on lucerne (*Medicago sativa*) seem to be most geographically widespread, having been reported from Europe, N. America, Argentina, Bolivia, Peru, Australia, and New Zealand. Red clover (*Trifolium pratense*) infestations have a similar distribution, except South America, but stem nematodes seem to be more common and severe in Scandinavia where there has been much study on the breeding of resistant varieties; white clover (*T. repens*) and alsike clover (*T. hybridum*) are also sometimes affected. Serious infestations on broad and/or field beans (*Vicia faba*) are known from Algeria, Britain, Germany and Portugal, the "giant race", found on these legumes, causing most damage in parts of Europe and in the USA. Tobacco (*Nicotiana tabacum*) is sometimes damaged in western Europe, particularly in Alsace. This nematode is also a troublesome pest of *Hydrangea hortensia* and phlox (*Phlox paniculata* or *P. drummondii*).
In countries of the Mediterranean region, including those in northern Africa, *D. dipsaci* is known mainly as a pest of field beans and onions. In North America, lucerne and red clover are the preferred hosts. Although regarded as a "cool season" nematode, it is found in warmer regions of the world, e.g., Central and South America, southern Africa, Australia, Iran, the Caribbean, India, etc.; mainly lucerne, garlic, and onion are attacked. Stem nematodes are also known to occur in, Japan, Hawaii, etc. Stem nematodes in, for example, flower bulbs and seeds of lucerne, field beans, onions, and other *Allium* spp. are on the list of quarantine organisms of many countries all over the world.

Distribution

Europe, Australia, New Zealand, South Africa, Russia, Chile, Argentina, Brazil, Columbia, Dominican Republic, USA.

Pest Significance

Ditylenchus dipsaci is of quarantine importance to the Caribbean.

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WEB RESOURCES:

http://ecoport.org/EP.exe$EntNameSrc
http://ucdnema.ucdavis.edu/imagemap/nemmap/ent156html/nemas/ditylenchusdipsaci

Fig. 1: Symptoms of chlorosis, wilting and death of garlic plants noticed in fields at Jabal Akhdar, Oman, due to nematode attack ID: 20584
Image ID 20584 Photo/illustration by: Al-Zidjali T.M. (26/08/1994)
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Fig. 2: Garlic plants exhibiting symptoms of soft-rot of cloves and brown discolouration following nematode attack in fields at Jabal Akhdar, Oman
Image ID 20585 Photo/illustration by: Al-Zidjali T.M. (26/08/1994)
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