EPIDEMIOLOGY AND MANAGEMENT OF *DITYLENCHUS DIPSACI* ON VEGETABLE CROPS IN SOUTHERN ITALY

Nicola Greco

Istituto di Nematologia Agraria, C.N.R., Via G. Amendola 165/A,70126 Bari, Italy.

ABSTRACT

Greco, N., 1993. Epidemiology and management of *Ditylenchus dipsaci* on vegetable crops in southern Italy. Nematropica 23:247–251.

Ditylenchus dipsaci is widespread in southern Italy. It reproduces on several wild and cultivated plant species. Among vegetables, the most severely damaged are onion and garlic, but broad bean, pea, and celery also suffer damage. In the Mediterranean area the nematode mainly infects host plants from September to May, but reproduction is greatest in October, November, March, and April when soil moisture, relative humidity, and temperatures are optimal. Symptoms of nematode attack are apparent in the field in late February to April and in nurseries in October and November. As a result, early crops are damaged more than late crops. Nematodes survive in the soil and in plant residues. However, seeds from infested plants, except those of broad bean and pea, have rarely been found to harbor nematodes. The use of seeds, bulbs, and seedlings free of nematodes is a prerequisite for successful crop production. Cropping systems, soil treatments with fumigant and non-volatile nematicides, and soil solarization of infested fields are recommended for effective and economic nematode control. Investigations to identify sources of resistance to the nematode must be encouraged.

Key words: Allium cepa, Allium sativum, Apium graveolens, broad bean, celery, control, *Ditylenchus dipsaci,* epidemiology, garlic, onion, pea, *Pisum sativum,* stem and bulb nematode, *Vicia faba.*

RESUMEN

Greco, N. 1993. Epidemiología y manejo de *Ditylenchus dipsaci* en cultivos hortícolas del sur de Italia. Nematrópica 23:247–251.

Ditylenchus dipsaci se encuentra ampliamente distribuido en el sur de Italia. Se reproduce tanto en especies de plantas no cultivadas como en de cultivos. Entre estos, la cebolla y el ajo son los más severamente afectados, aunque el frijol ancho, la arveja y el apio sufren también daños. En el área mediterránea los nematodos infectan a las plantas hospedantes de septiembre a mayo aunque su reproducción es más alta en octubre y noviembre, marzo y abril cuando la humedad del suelo y la temperatura y humedad ambiental son óptimas. Los síntomas en plantas afectadas por nematodos se manifiestan en el campo desde finales de febrero hasta abril, mientras que en los víveros estos ocurren en octubre y noviembre. En consecuencia, las siembras tempranas son más afectadas que las tardías. Los nematodos sobreviven en el suelo y en residuos. Las semillas de plantas infectadas rara vez contienen nematodos con las excepciones de el frijol ancho y la arveja. La utilización de semillas, bulbos y plántulas libres de nematodos es un prerequisito para una buena cosecha. Las rotaciones de cultivos, aplicaciones de nematicidas fumigantes y no fumigantes así como la solarización de suelos infestados son recomendaciones efectivas y económicas para controlar nematodos. No obstante, deben fomentarse las investigaciones sobre fuentes de resistencia.

Palabras clave: ajo, *Allium cepa, Allium sativum,* apio, *Apium graveolens,* arveja, cebolla, control, *Ditylenchus dipsaci,* epidemiología, frijol ancho, nematodo de tallo y bulbo, *Pisum sativum, Vicia faba.*

INTRODUCTION

The stem and bulb nematode, *Ditylenchus dipsaci* (Kühn) Filipjev, is one of the most damaging nematodes worldwide. In Europe, several field and cash crops are severely damaged by the nematode (2). This has resulted in quarantine regulations to avoid the spread of material infected by this parasite across different countries. *Ditylenchus dipsaci* is reported to damage many crops in the Mediterranean basin. In southern Italy, it causes extensive yield

losses of onion (*Allium cepa* L.), strawberry (*Fragaria vesca* L.), broad bean (*Vicia faba* L.), pea (*Pisum sativum* L.), and celery (*Apium graveolens* L.) (4,11,17). There is also a single finding of the nematode causing stem necrosis of tomato in a greenhouse in Sardinia. In other areas of Italy *D. dipsaci* is so noxious to garlic (*Allium sativum* L.) that several regulatory and growers' organizations have co-operated in a phytosanitary certification scheme to produce healthy material and limit yield loss.

EPIDEMIOLOGY AND YIELD LOSS

Ditylenchus dipsaci develops at 15–30 °C (2) and infection is enhanced when aerial parts of plants are wetted by rain, fog, dew, or sprinkler irrigation (2,4). Because of the mild winters in southern Italy, especially in coastal areas, many vegetables are planted in late summer or early fall and grow throughout the winter and spring. At this time, conditions are optimal for nematode development. Infection occurs in mid fall (October–November) and again from the end of winter (March) until mid spring (May), when most of the rainfall is concentrated.

Onion nurseries in southern Italy are established in September and seedlings can be transplanted from November (early varieties) until the end of January (late varieties), for harvest from May to July, respectively. Symptoms of nematode attack are evident in onion nurseries in October and November (4). In the field, the nematode infests the seedlings soon after transplanting and thousands of nematodes can be extracted from them 1 month later, when many plants may die. In winter, if the temperature drops to 10 °C or less, nematode reproduction is suppressed but increases with the increase of temperature in spring (4). Leaf distortion and bulb rot, which are characteristic symptoms of nematode attack, are evident by the end of winter, although many plants may die much earlier without showing symptoms. Late in spring (May–June), higher air temperatures and low humidity suppress nematode infestation and reproduction, and many nematodes move into the soil. Others may remain in the bulbs or in plant residues thereby ensuring their survival. By the harvest of late varieties (June–July) few nematodes are present in the bulbs and none in the seeds (4) even if the plants are in heavily infested soil. Although onions are grown for consumption or for seed in the same area, in many cases the seed stocks used are produced in other areas of Italy or are imported and may be infested with nematodes. Fortunately, in some years the weather from fall to spring is rather dry and only a limited amount of damage occurs, even in heavily infested soil.

Time of planting also affects the amount of onion damage. Early varieties, which are planted in November under favorable environmental conditions, are damaged more than late varieties, which are transplanted late in January or February (7). These findings were confirmed by Vovlas *et al.* (16) who observed no infection by *D. dipsaci* on strawberry in July–August and two peaks of nematode numbers, one in November and the other in March.

Faba bean is usually sown in November and plants emerge 1 month later. The crops are dense from late March onwards, thus reducing water evaporation and prolonging the time the plants remain wet because of rain or dew. Therefore, although the nematode may infest broad bean seedlings at an early stage, nematodes in plant tissues increase greatly in April and accumulate at the base of the stem by harvest (11). Symptoms of nematode at-

tack are obvious in early spring when the stem base shows extensive necrosis and reddish areas that can be confused with those caused by fungal diseases. Nematodes are few or absent in the top of the plant and are not found in the seeds (11), thus suggesting that populations of the nematode from southern Italy are not of the oat or giant races (13). The impact of *D. dipsaci* on broad bean yield is not well known.

Pea has also been found infested by *D. dipsaci* (10). Pea varieties cultivated in southern Italy are prostrate and this favors nematode infection which may lead to plant death. The impact of *D. dipsaci* on pea yield has not been estimated, but based on the spread of the nematode in southern Italy and on the severity of the symptoms it causes on infested pea plants, heavy yield loss must be expected during mild and rainy winters and springs. All plant parts have been found infested; stems and leaves of infested plants show extensive necrosis, while pods become distorted and contain a few seeds that harbor nematodes.

Recently (16) damage by *D. dipsaci* has been observed on celery. Basal and external plant parts were the most damaged and showed extensive necrosis, resulting in unmarketable plants.

Investigations on the host range of populations of *D. dipsaci* from southern Italy revealed that onion, strawberry, and broad bean are good hosts for the nematode while garlic is a poor or non host (11). In central Italy, however, garlic is widely cultivated in the province of Piacenza and severe damage by *D. dipsaci* occurs during May–June (15). This indicates that at least two races of the nematode are present in Italy.

Investigations on karyotypes of populations of *D. dipsaci* (1) revealed that all populations from southern Italy, although from different hosts, had the same number of chromosomes (2n = 24). A Dutch population from onion, and one from broad bean in Malta also had 2n = 24. However, in the Mediterranean basin large differences in the number of chromosomes were observed in populations from broad bean in Portugal (2n = 12) and in Malta (2n = 24; 2n = 54; 2n = 60). Chromosomal differences also occurred in populations of *D. dipsaci* from alfalfa (2n = 12) and onion (2n = 24) in Chile (12).

NEMATODE MANAGEMENT

Although *Ditylenchus dipsaci* may reproduce on some 450 plant species, the different races each reproduce on only a limited number (2). Therefore, knowledge of the nematode race and of its host range is a prerequisite for controlling *D. dipsaci* by crop rotation. However, it seems that alternating winter with summer crops could reduce nematode densities in the soil and thus limit yield losses of host crops in warm areas.

In nurseries, nematicides applied to the soil or sprayed onto the aerial plant parts have given satisfactory nematode control (5,6). Soil fumigation before sowing followed by two or three sprays of systemic nematicides, starting after plant emergence and ending 7–10 days before they are collected for transplanting, enables production of onion seedlings that are nearly free from *D. dipsaci*, even in heavily infested soil (6). Under field conditions, the use of soil fumigants (such as 1,3 D at 200–300 L/ha, 1,3 D + isothiocyanate at 200–300 L/ha, or dazomet at 500 kg/ha, all applied 3–4 weeks before transplanting), or application of non-fumigant nematicides (such as aldicarb or fenamiphos at 10 kg a.i./ha 7–10 days before transplanting) suppress nematode

densities and increase onion yield (5,9). Although these treatments are expensive and are not suggested for the control of *D. dipsaci* on broad bean, or on pea, and perhaps garlic, they may help in the production of seeds and bulbs free of the nematode and thus prevent its spread.

Subtropical countries are characterized by having dry hot summers during which often no crops are cultivated. In these countries soil solarization has proved effective. Investigations in Italy on onion (8,9) and Israel on garlic (14) demonstrated that a 4–8 week solarization period may provide better control of the nematode and a higher yield increase than soil fumigation.

Although solarization and nematicide treatments can be beneficial, the control of *D. dipsaci* on onion and garlic must be based primarily on the use of seeds and bulbs that are free of the nematode. In Italy, garlic was severely damaged by *D. dipsaci* in past years. Today, thanks to the cooperation among the Italian Institute for Elite Seeds (ENSE), the Phytosanitary Provincial Consortium of Piacenza, garlic seed bulb producers, and the Nematology Laboratory of the Plant Protection Service of Bologna, *D. dipsaci* is kept under control. A team comprising one representative from each of the first three organizations surveys garlic crops designated for the production of garlic seed bulbs twice a year, in May and June. During each survey, 50 garlic plants are collected from a 0.3-ha area of each field and sent to the nematology laboratory for analysis. Only garlic from certified fields are marketed. This cooperation has led to a large decrease in the number of fields found to be infested by *D. dipsaci*. In 1978, 60% of the fields were infested, which was reduced to 6% by 1988 (15).

Unfortunately, no resistant cultivar with good agronomic characteristics is available, although resistance has been reported in broad bean.

CONCLUSIONS

Ditylenchus dipsaci is widespread in southern Italy and in the Mediterranean basin. Although it is known as a severe pest of cash crops such as garlic, onion, and strawberry, its impact on other crops has been overlooked. The nematode is common in broad bean and pea fields but the extent to which it reduces crop yield and tolerance to drought (which is very frequent in southern Italy from late spring onwards) is not known.

In the field, methods for controlling *D. dipsaci* should be based primarily on the use of plant material free of nematodes and on agronomic practices aimed at preventing environmental conditions that favor nematode infection. In this regard, row spacing, weed control, time of planting, and irrigation must be carefully considered as elements of integrated pest management. Identification of the nematode races occurring in different areas and of their host range is also necessary for the application of control by crop rotation.

The use of expensive methods of control, such as nematicides and soil solarization, alone or in combination, cooperation among seed producers and national research institutions, and adoption of quarantine regulations should be encouraged to ensure the production and marketing of seeds free from nematodes. Moreover, screening of germplasm should be encouraged to identify sources of nematode resistance that might be used in breeding programs aimed at releasing cultivars having both resistance to *D. dipsaci* and good agronomic characteristics.

LITERATURE CITED

1. D'ADDABBO GALLO, M., M. R. MORONE DE LUCIA, S. GRIMALDI DE ZIO, and F. LAMBERTI. 1982. Caryo-phenotype relationships in *Ditylenchus dipsaci*. Nematologia mediterranea 10:30–47.
2. CAUBEL, G. 1971. Le problème du nématode des tiges et des bulbes en France. Pp. 191–256 *in* Les Nématodes des Cultures: Journées Francaises d'Études et d'Information, Paris, France, 3–5 November, 1971.
3. GRECO, N. 1976. Piante infestanti ospiti di *Ditylenchus dipsaci* in Puglia. Nematologia mediterranea 4:99–102.
4. GRECO, N., F. LAMBERTI, and A. BRANDONISIO. 1974. Indagini su biologia ed epidemiologia di *Ditylenchus dipsaci* (Kühn) Filipjev su cipolla in Puglia. Nematologia mediterranea 2:149–157.
5. GRECO, N., F. LAMBERTI, and A. BRANDONISIO. 1974. La lotta chimica contro *Ditylenchus dipsaci* (Kühn) Filipjev su cipolla in Puglia. Nematologia mediterranea 2:117–139.
6. GRECO, N., F. LAMBERTI, and A. BRANDONISIO. 1976. Produzione di semenzali di cipolla esenti da *Ditylenchus dipaci*. Nematologia mediterranea 4:71–77.
7. GRECO, N., F. LAMBERTI, and A. BRANDONISIO. 1976. Suscettibilità di tre varietà di cipolla a *Ditylenchus dipsaci*. Nematologia mediterranea 4:57–62.
8. GRECO, N., A. BRANDONISIO, and F. ELIA. 1985. Control of *Ditylenchus dipsaci, Heterodera carotae* and *Meloidogyne javanica* by solarization. Nematologia mediterranea 13:191–197.
9. GRECO, N., T. D'ADDABBO, V. STEA, and A. BRANDONISIO. 1992. The synergism of soil solarization with fumigant nematicides and straw for the control of *Heterodera carotae* and *Ditylenchus dipsaci*. Nematologia mediterranea 20:25–32.
10. INSERRA, R. N., and N. VOVLAS. 1979. Aspetti della sintomatologia delle infestazioni di *Ditylenchus dipsaci* su pisello. Pp. 123–133 *in* Proceedings, Giornate Nematologiche, 28–29 November 1979, Florence, Italy.
11. LAMBERTI, F., and N. GRECO. 1974. Piante coltivate ospiti di *Ditylenchus dipsaci* (Kühn) Filipjev in Puglia. Nematologia mediterranea 2:159–164.
12. LAMBERTI, F., S. GRIMALDI DE ZIO, and A. AGOSTINELLI. 1988. Caryo-phenotypes of *Ditylenchus dipsaci* in Chile. Nematologia mediterranea 16:147.
13. SIKORA, R. A., and N. GRECO. 1990. Nematode parasites of food legumes. Pp. 181–235 *in* M. Luc, R. A. Sikora, and J. Bridge, eds. Plant Parasitic Nematodes in Subtropical and Tropical Agriculture. CAB International: Wallingford, U.K.
14. SITI, E., E. COHN, J. KATAN, and M. MORDECHAI. 1982. Control of *Ditylenchus dipsaci* in garlic by bulb and soil treatments. Phytoparasitica 10:93–100.
15. TACCONI, R. 1989. Produzione di "Aglio bianco piacentino" esente dal nematode dello stelo e dei bulbi. L'Informatore Agrario 45(21):63–64.
16. VOVLAS, N., R. N. INSERRA, and F. LAMBERTI. 1978. Il *Ditylenchus dipsaci* su fragola nell'Italia Meridionale e relativi metodi di lotta. Rivista di Ortofrutticoltura Italiana 62:253–268.
17. VOVLAS, N., V. A. MELILLO, and L. CATALANO. 1993. Il nematode *Ditylenchus dipsaci*, agente di gravi danni su colture di sedano in Puglia. Nematologia mediterranea 21:55–57.

Received: *9.VII.1993*
Recibido:

Accepted for publication: *29.IX.1993*
Aceptado para publicación: