# NEMATODE DISEASES OF SOME FLOWERING ORNAMENTAL PLANTS

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Enormous interest has been shown by plant pathologists in nematodes causing plant diseases. These nematodes cause the diseased conditions either alone or in conjugation with fungi or bacteria. Although much of the work deals with nematode diseases of field crops, there is a relatively large amount of literature on nematode diseases of flowering ornamental plants especially those grown in greenhouses. A nematode disease of Chrysanthemum was reported as early as 1890 in England and 1901 in the United States. There is evidence that considerable losses to flowering ornamental plants like Irises, Narcissus, etc. (5) are caused by nematodes, although exact loss in numeral figures is lacking. The typical losses on flowering ornamental plants are poor growth and reduction either in number or size of flowers. Importance of nematode diseases on ornamental plants can be easily noticed by the fact that a U.S. Federal quarantine was passed as early as 1926 to restrict the movement of Narcissus bulbs from infested areas.

The life history of nematodes is fairly simple, the female lays eggs which hatch into larvae. Generally the larvae molt four times before maturation. Those that live inside the host, *Heterodera* and *Meloidogyne*, for example, infect the host at the first and second stage larvae respectively. Others generally infect at any larval or adult stage. Nematodes may be unisexual, bisexual or syngonic. They infect either aerial or the underground parts of the plant. Those that infect the aerial parts of the flowering ornamental plants so far have been reported to belong to the genera *Aphelenchoides* and *Ditylenchus*. These generally feed within plant tissues, either leaves, buds, or tender stems.

Among the nematodes which infect and remain inside the root system, the genus *Meloidogyne* is perhaps the most important. Among the nematodes which infect the internal parts but do not remain there, species of *Pratylenchus*, *Hoplolaimus*, *Helicotylenchus*, are the most important. Among the genera which infect the exterior parts of roots, *Xiphinema* is fairly common.

In this paper only some common flowering ornamental plants are included. The sixteen species selected belongs to the following families : 4 in the Compositae, 2 in the Iridaceae, 2 in the Liliaceae, 1 in the Amaryllidaceae, 1 in the Begoniaceae, 1 in the Caryophyllaceae, 1 in the Polemoniaceae, 1 in the Rosaceae, 1 in the Serophulariaceae, 1 in the Solanaceae, and 1 in the Violaceae.

Also, the biology of diseases, source of infection, conditions favorable for the disease and symptoms peculiar to each disease are briefly described. The control of the disease is treated separately in a general manner.

Among the nematodes parasitic on ornamental plants *Meloidogyne* spp. and *Pratylenchus* spp. are the most commonly found. Surveys of ornamental nurseries in

California showed that 82% were infested with *Meloidogyne* spp. and 57 % with *Pratylenchus* spp. (*20*).

The following Table 1 lists the 16 species of plants with the nematodes reported to attack them (*10*).

## BIOLOGY OF THE DISEASE

*Source of infection.* Table 1 includes a number of genera of plant parasitic nematodes. These genera have great differences in their biology. However, they are grouped together for the convenience of a more comprehensive discussion.

Infested soil is the most important source of primary infection especially for *Meloidogyne* spp., *Heterodera* spp., *Xiphinema* spp. and *Pratylenchus* sp. Infected plants are probably just as important as a source of infection because they can carry not only these nematodes but others like *Aphelenchoides*. and *Ditylenchus*. However, it should be mentioned that all plant parasitic nematodes can survive in the soil and plant tissues for different periods of time depending on the environmental conditions. For instance, Allen and Raski (*1*) reported that the source of infection of Begonia was the soil infested with *Pratylenchus* sp. Thomas (*29*) described that infected bulbs of narcissus probably constituted the most important source of infection. Magie and Cowperthwaite (*14*), Perry (*15*) and Smith (*23*) mentioned that the rootknot nematode of gladiolus could be carried through the storage period within the infected corms and spread around by shipments to distant areas.

So it seems to appear that the main source of inoculum and spread is through commercial greenhouses and nurseries, where infected plants are sold and distributed over large areas.

*Conditions favorable to disease.* Besidse the availability of inoculum, susceptible hosts are necessary for the development of the disease. With both factors present, the environment is the next in importance. These environmental conditions in some cases are very critical. Moisture, temperature and type of soil seem to be most important. Edwards (*7*) reported that water in the form of dew, rain or overhead watering is necessary for the mobility of *Aphelenchoides ritzema-bosi* on Chrysanthemum. However, this nema can survive as quiescent larvae within dry plant tissue for at least 3 years. Courtney (*5*) described that root-knot, lance, and meadow nematodes caused more severe damage under warmer sections of the United States, while the bulb and stem, and bud and leaf nematodes were more serious under cooler conditions. Slootweg (*22*) working in Holland concluded that *Pratylenchus* sp. could be found in sand, sandy clay, and peat soils but not in clay soils in areas where bulbs or corms of tulips, hyacinths and gladiolus were grown.

## SYMPTOMS

There exist very many symptoms that individual plant species will show to a given species of nematodes. In this paper the symptoms are grouped under three kinds depending on the plant parts attacked: 1. aerial parts of plants, 2. roots, and 3. bulbs and corms.

*Symptoms caused by nematodes attacking aerial parts.* Infections caused by *Aphelenchoides* spp. show necrotic lesions on the leaves and flowers delimited by the veins, when found on Aster, Begonia, Chrysanthemum. Dahlia, Iris, Narcissus, Phlox, Snapdragon, and Zinnia; on African Violet the symptoms appear on leaves, petioles and flowers with minor variations and the lesions are not delimited by the veins as other plants. These lesions start

as a water soaked spots and spread from the lower leaves to the upper ones. (*6, 7, 19, 23, 24*).

The infection by *Ditylenchus* is characterized by stunting and distortion of the whole plant. Further increase of nematodes causes leaves to become pallid with a yellowish motling and longitudinal streaking. Flowering is delayed and later the foliage becomes swollen and easily torn. These symptoms with minor variations can be applied for the following plants: Aster, Begonia, Carnation, Chrysanthemum, Dahlia, Hyacinths, Iris, Narcissus, Phlox, Roses and Tulips. (*5, 8, 23, 29*).

*Symptoms caused by nematodes attacking roots.* The general symptoms that can be observed when plants are attacked by *Pratylenchus* sp. are poor growth and stunting, reduction in number of flowers and small size of flowers. Roots rot and disintergrate, and in some cases small brown lesions can be observed in the roots. This is true for Begonia, Carnation, Chrysanthemum, Iris, Narcissus, Phlox, Rose, Snapdragon, Tulip and Violet. (*1, 2, 22, 28*).

Infections caused by *Meloidogyne* sp. are characterized by compact dwarfed habit of growth, brown discoloration of the roots, root proliferation and the characteristic gall formation. With exception of Hyacinths all other flowering ornamental plants here included are susceptible and show about the same symptoms. (*15, 19, 23, 27, 28*)

Schindler (*17*) found *Xiphinema diversicaudatum* attacking roses and was able to obtain infection with artificial inoculations. The symptoms consisted of small galls in roots of roses. This was the first report of gall formation by an ectoparasite.

*Symptoms caused by nematodes on bulbs and corms.* When bulbs and corms are attacked by *Ditylenchus* sp., they become smaller and will show discoloration. Gladiolus corms show brownish lesions, while Iris bulbs have dark depressing lesions and brown ring spots appear on Narcissus tubers. (*5, 8, 12, 14, 22, 29*).

Smith (*23*) described Dahlia tubers as attacked by *Meloidogyne* sp., the root-knot nematode. The symptoms on the bulbs are characterized by galls, or pimply swellings of tubers. The aerial parts show the same symptoms described when this nematode attacks roots.

## CONTROL

In order to control nematodes causing disease of flowering ornamental plants successfully it is necessary to have a good knowledge of their life cycle, nature of infection, host range, and conditions favorable and unfavorable for their infection and survival. The most pressing need is effective and economical control measures. In general, control measures can be attempted through one or more of the following methods.

### *Treatment of Plant Parts*

*1. Nonchemical control.* The hot water treatment is probably one of the most widely used. Several kinds of bulbs, corms, and tubers of ornamental plants can safely be exposed for a time to temperature treatment lethal to a particular nematode species. This is possible in the case of plants which are vegetatively propagated. The hot water treatment recommended for some of the ornamental plants is given below.

Edwards (*7*) recommended treatment of Chrysanthemum cuttings to control *Aphelenchoides* with a hot water at a temperature of 110 F for 30 minutes.

Smith (*23*) found that soaking Narcissus bulbs in water with formalin (1 pint per 25 gallons of water) maintained at a temperature of 110-111.5 F for 3 hours gave good control of the bulb nematode *Ditylenchus* species.

TABLE 1
Lists of reported nematodes and host plants

| Host | | Nematode | | |
|---|---|---|---|---|
| Common Name | Botanical Name | Nema | Reported by | Year |
| 1. Aster | *Aster* sp. | | | |
| (Compositae) | *A. alpinus* L. | *Meloidogyne* sp. | B.C. & S. | 1933 |
| | *A. alpinus* L.v. altaicus | *Aphelenchoides fragariae* | Junges | 1938 |
| | | *Aphelenchoides ritzema–bosi* | Junges | 1938 |
| | *A. caucasicus* Willd. | *Aphelenchoides ritzema–bosi* | Junges | 1938 |
| | *A. novi–belgii* L. | *Aphelenchoides ritzema–bosi* | Junges | 1938 |
| | *A. pattersoni* A. Gray | *Aphelenchoides fragariae* | Junges | 1938 |
| | *A. squamatus* | *Ditylenchus dipsaci* | Burkart | 1937 |
| | *Aster* sp. | *Aphelenchoides ritzema–bosi* | Voss | 1930 |
| | (Michaelmas daisy) | *Meloidogyne hapla* | Martin | 1954 |
| | | *Meloidogyne* sp. | Sturgis | 1893 |
| | *Aster tradescanti* L. | *Aphelenchoides ritzema–bosi* | Crossman & Christie | 1936 |
| | | *Meloidogyne* sp. | Goff | 1936 |
| 2. Begonia | *Begonia* sp. | | | |
| (Begoniaceae) | *B. Coccinea* Hook | *Meloidogyne* sp. | Selby | 1896 |
| | *B. Coccinea* Hook v. Lucerna | *Meloidogyne* sp. | Buhrer | 1938 |
| | *B. fuchsioides* Hook | *Aphelenchoides fragariae* | Marcinowski | 1908 |
| | *B. maculata* Raddi | *Meloidogyne* sp. | B.C. & S. | 1933 |
| | *B. metallica* Sm. | *Meloidogyne* sp. | Selby | 1896 |
| | *B. Olbia* kerchove | *Meloidogyne* sp. | Selby | 1896 |
| | *B. rex* Putz | *Aphelenchoides fragariae* | Smolak | 1925 |
| | | *Meloidogyne* sp. | Molliard | 1900 |

TABLE 1 (continued)

Lists of reported nematodes and host plants

| Host | | Nematode | | |
|---|---|---|---|---|
| Common Name | Botanical Name | Nema | Reported by | Year |
| | | *Pratylenchus penetrans* | Seinhorst | 1954 |
| | *B. semperflorens* Link & Otto | *Rotylenchulus reniformis* | Linford & Yap | 1940 |
| | *B. semperflorens* Link & Otto v. Vernon | *Aphelenchoides fragariae* | Marcinowski | 1908 |
| | | *Meloidogyne* sp. | Buhrer | 1938 |
| | *Begonia* sp. Gloire de Lorraine | *Aphelenchoides fragariae* | *Sorauer* | 1902 |
| | | *Aphelenchoides ritzema-bosi* | Lindhardt | 1952 |
| | *B. tuberhybrida* Voss | *Ditylenchus dipsaci* | T. Goodey | 1929 |
| | | *Meloidogyne sp.* | Li & shao | 1947 |
| | | *Pratylenchus penetrans* | Sher & Allen | 1953 |
| | | *Pratylenchus* sp. | Allen & Ruski | 1952 |
| 3. Carnation | *Dianthus* sp. | | | |
| (Caryophyllaceae) | *D. barbatus* L. | *Ditylenchus dipsaci* | Wilson | 1930 |
| | | *Heterodera schachtii* v. *trifolii* | Winslow | 1954 |
| | | *Meloidogyne* sp. | Bessey | 1911 |
| | *D. caryophyllus* L. | *Ditylenchus dipsaci* | Bos | 1888–92 |
| | | *Heterodera schachtii* | Chatin | 1891 |
| | | *Heterodera schachtii* v. *trifolii* | Raski & Hart | 1953 |
| | | *Meloidogyne arenaria* | Sasser | 1954 |
| | | *Meloidogyne hapla* | Sasser | 1954 |
| | | *Meloidogyne incognita* | Sasser | 1954 |
| | | *Meloidogyne incognita* v. *acrita* | Sassar | 1954 |
| | | *Meloidogyne javanica* | Chitwood | 1949 |
| | | *Meloidogyne* sp. | Trelease | 1894 |
| | | *Pratylenchus pratensis* | Crossman & Christie | 1937 |

TABLE 1 (continued)

Lists of reported nematodes and host plants

| Host | | Nematode | | |
|---|---|---|---|---|
| Common Name | Botancial Name | Nema | Reported by | Year |
| | *D. chinensis* L. v. *heddewigii* Regel | *Meloidogyne* sp. | Bessey | 1911 |
| | *D. deltoides* L. | *Ditylenchus dipsaci* | T. Goodey | 1940 |
| | | *Heterodera schachtii* | Winslow | 1954 |
| | | *Heterodera schachtii* v. *trifolii* | Winslow | 1954 |
| | *D. plumarius* L. | *Ditylenchus dipsaci* | Bos | 1904 |
| | | *Meloidogyne* sp. | Bessey | 1911 |
| | *Dianthus* sp. | *Heterodera schachtii* | Jones | 1950 |
| | | *Meloidogyne* sp. | B. C. & S. | 1933 |
| 4. Chrysanthemum | *Chrysanthemum* sp. | | | |
| (Compositae) | *C. balsamita* L. | *Aphelenchoides ritzema-bosi* | Junges | 1938 |
| | *C. cinerariifolium* (Trev.) Vis. | *Aphelenchoides ritzema-bosi* | Junges | 1938 |
| | | *Ditylenchus dipsaci* | Kirjanova | 1939 |
| | | *Meloidogyne* sp. | Gvozdenovic | 1902 |
| | *C. coccineum* Willd | *Aphelenchoides ritzema-bosi* | Walton in T. Goodey | 1940 |
| | | *Meloidogyne* sp. | Wilson | 1937 |
| | | *Pratylenchus penetrans* | Seinhorst | 1954 |
| | *C. coronarium* L. | *Meloidogyne incognita* v. *acrita* | Martin | 1955 |
| | | *Meloidogyne* sp. | Goff | 1936 |
| | *C. frutescens* L. | *Meloidogyne* sp. | Jumelle & Raybaud | 1909 |
| | *C. hortorum* Bailey | *Aphelenchoides fragariae* | Crossman & Christie | 1936 |
| | | *Meloidogyne* sp. | Buhrer | 1938 |
| | *C. indicum* L. | *Aphelenchoides fragariae* | Crossman & Christie | 1936 |
| | | *Aphelenchoides ritzema-bosi* | Crossman & Christie | 1936 |
| | | *Meloidogyne* sp. | Buhrer | 1938 |
| | | *Pratylenchus penetrans* | Seinhorst | 1954 |

TABLE 1 (continued)

Lists of reported nematodes and host plants

| Host | | Nematode | | |
|---|---|---|---|---|
| Common Name | Botanical Name | Nema | Reported by | Year |
| | *C. leucanthemum* L. | *Aphelenhoides fragariae* | Poeteren | 1922 |
| | | *Aphelenchoides ritzema-bosi* | Voss | 1930 |
| | | *Ditylenchus dipsaci* | C.S. & B. | 1934 |
| | | *Meloidogyne* sp. | Baldrati | 1900 |
| | *C. leucanthemum* L. v. *Flore Pleno* | *Meloidogyne* sp. | B.C. & S. | 1933 |
| | *C. leucanthemum* L. v. *Pinnatifidum* | *Meloidogyne* sp. | B.C. & S. | 1933 |
| | *C. maximum* Ram. | *Aphelenchoides Besseyi* | Sher | 1954 |
| | | *Aphelenchoides ritzema-bosi* | Junges | 1938 |
| | | *Meloidogyne hapla* | Martin | 1954 |
| | | *Meloidogyne* sp. | Wacker | 1931 |
| | *C. morifolium* Ram | *Aphelenchoides besseyi* | Sher | 1954 |
| | | *Aphelenchoides ritzema-bosi* | Schwartz | 1911 |
| | | *Meloidogyne hapla* | Martin | 1955 |
| | | *Meloidogyne* sp. | Nagakura | 1930 |
| | *C. parthenium* Bernh | *Aphelenchoides ritzem-bosi* | Junges | 1938 |
| | *C. roseum* Adam | *Meloidogyne* sp. | Buhrer | 1938 |
| | *C. rubellum* Sealy | *Aphelenchoides ritzema-bosi* | Wilson in T. Goodey | 1940 |
| | *C. segetum* L. | *Ditylenchus dipsaci* | Goffart | 1941 |
| | *Chrysanthemum* sp. | *Aphelenchoides fragariae* | Grossman & Christie | 1936 |
| | | *Aphelenchoides ritzema-bosi* | Crossman & Christie | 1936 |
| | | *Meloidogyne* sp. | Bessey | 1911 |
| | | *Paratylenchus* sp. | Tarjan | 1951 |
| | *C. uliginosum* Pers. | *Meloidogyne* sp. | B.C. & S. | 1933 |
| 5. Dahlia (Compositae) | *Dahlia* sp. | *Aphelenchoides fragariae* | Lindhardt | 1950 |
| | | *Aphelenchoides limberi* | Steiner | 1940 |

TABLE 1 (continued)

Lists of reported nematodes and host plants

| Host | | Nematode | | |
|---|---|---|---|---|
| Common Name | Botanical Name | Nema | Reported by | Year |
| | | *Aphelenchoides ritzema-bosi* | Crossman & Christie | 1936 |
| | | *Meloidogyne* sp. | B.C. & S. | 1933 |
| | *D. variabilis* Desf. | *Aphelenchoides besseyi* | Sher | 1954 |
| | | *Aphelenchoides fragariae* | Lindhardt | 1952 |
| | | *Aphelnechoides ritzema-bosi* | Weber | 1926 |
| | | *Meloidogyne* sp. | Neal | 1889 |
| 6. Gladiolus | *Gladiolus* sp. | | | |
| (Iridaceae) | *G. gandavensis* Van Houtte | *Meloidogyne* sp. | Ustinov | 1939 |
| | *G. hybridus* Hort. | *Ditylenchus destructor* | J.B. Goodey | 1952 |
| | | *Ditylenchus dipsaci* | T. Goodey | 1929 |
| | | *Meloidogyne* sp. | Bessey | 1911 |
| | *G. primulinus* Baker, V.S. | *Ditylenchus dipsaci* | Steiner & Buhrer | 1932 |
| | *Gladiolus* sp. | *Meloidogyne hapla* | Perry | 1952 |
| | | *Meloidogyne* sp. | B.C. & S. | 1933 |
| 7. Hyacinthus | *Hyacinthus* sp. | | | |
| (Liliaceae) | *H. orientalis* L. | *Ditylenchus dipsaci* | de Vries | 1882 |
| | *H. romanus* L. | *Ditylenchus dipsaci* | Prillieux | 1881 |
| | *Hyacinthus* sp. | *Ditylenchus dipsaci* | Anon. | 1932 |
| 8. Iris | *Iris* sp. | | | |
| (Iridaceae) | *I. filifolia* Boiss | *Ditylenchus destructor* | Tschaen | 1932 |
| | *I. germanica* L. | *Meloidogyne* sp. | B.C. & S. | 1933 |
| | | *Pratylenchus penetrans* | Seinhorst | 1954 |
| | *I. histrioides* Dykes | *Ditylenchus destructor* | Anon. | 1935 |
| | *I. kaempferi* Sieb. | *Meloidogyne* sp. | B.C. & S. | 1933 |
| | *I. laevigata* Fish *v. yamato* Nishiki | *Meloidogyne* sp. | Steiner & Buhrer | 1934 |
| | *I. siberica* L. | *Meloidogyne* sp. | B.C. & S. | 1933 |
| | *Iris* spp | *Anguillulina* sp. | Crossman & Christie | 1937 |

TABLE 1 (continued)

Lists of reported nematodes and host plants

| Host | | Nematode | | |
|---|---|---|---|---|
| Common Name | Botanical Name | Nema | Reported by | Year |
| | | *Aphelenchoides fragaria* | Crossman & Christie | 1936 |
| | | *Aphelenchoides ritzema-bosi* | Junges | 1938 |
| | | *Ditylenchus destructor* | Poeteren | 1925 |
| | | *Meloidogyne* sp. | Brick | 1905 |
| | | *Pratylenchus Pratensis* | Crossman & Christie | 1939 |
| | *Iris* sp. (bulbous) | *Aphelenchoides blastophthorus* | Oostenbrink | 1953 |
| | *Iris* sp. (perennial) | *Meloidogyne hapla* | Martin | (litt.) |
| | | *Meloidogyne javanica* | Martin | (litt.) |
| | *Iris tingitana* Boiss & Reut. | *Ditylenchus destructor* | Tschaen | 1932 |
| | | *Meloidogyne* sp. | Steiner & Buhrer | 1933 |
| | *I. tingitana* Boiss & Reut. | *Ditylenchus destructor* | J.B. Goodey | 1951 |
| | (Dutch Iris) | *Ditylenchus destructor* | Anon. | 1935 |
| | V.S. Wedgewood | *Meloidogyne* sp. | Steiner & Buhrer | 1933 |
| | *I. xiphiodes* Ehrh. | *Ditylenchus destructor* | J.B. Goodey | 1951 |
| | | *Ditylenchus destructor* | Steiner & Buhrer | 1933 |
| | *I. xiphium* L. | *Ditylenchus destructor* | J.B. Goodey | 1951 |
| | | *Ditylenchus destructor* | T. Goodey | 1929 |
| | | *Meloidogyne* sp. | Calvino | 1950 |
| 9. Narcissus | *Narcissus* sp. | | | |
| (Amaryllidaceae) | *N. cyclamineus* Baker | *Ditylenchus dipsaci* | Wilson | 1943 |
| | *N. incomparabilis* Mill | *Ditylenchus dipsaci* | Steiner & Buhrer | 1932 |
| | *N. poeticus* L. | *Ditylenchus dipsaci* | Bos | 1922 |
| | *N. poeticus* L. v. Ornatus | *Ditylenchus dipsaci* | Steiner & Buhrer | 1932 |
| | *N. pseudonarcissus* L. | *Aphelenchoides fragariae* | Allen | 1952 |
| | | *Aphelenchoides subtenuis* | T. Goodey | 1935 |
| | | *Ditylenchus dipsaci* | Bos | 1917 |

TABLE 1 (continued)

Lists of reported nematodes and host plants

| Host | | Nematodes | | |
|---|---|---|---|---|
| Common Name | Botanical Name | Nema | Reported by | Year |
| | *Narcissus* sp. | *Aphelenchoides subtenuis* | Cobb | 1926 |
| | | *Meloidogyne* sp. | Presley | 1947 |
| | | *Pratylenchus pratensis* | T. Goodey | 1932 |
| | *N. tazetta* L. | *Ditylenchus dipsaci* | Bos | 1988–92 |
| | *N. tazetta* L. v. *chinensis* | *Meloidogyne* sp. | Li & Shao | 1947 |
| 10. Petunia | *Petunia* sp. | | | |
| (Solanaceae) | *P. hybrida* vilm | *Meloidogyne haple* | Martin | 1954 |
| | | *Meloidogyne javanica* | Martin | 1954 |
| | | *Meloidogyne* sp. | Bessey | 1911 |
| | *Petunia* sp. | *Meloidogyne* sp. | B.C. & S. | 1933 |
| | *P. violacea* Lindl | *Meloidogyne* sp. | Ustinov | 1939 |
| 11. Phlox | *Phlox* sp. | | | |
| (Polemoniaceae) | *P. amoena* sims | *Ditylenchus dipsaci* | Baudys | 1948 |
| | *P. divaricata* L. | *Ditylenchus dipsaci* | Wilson | 1930 |
| | *P. drummondii* Hook | *Aphelenchoides ritzema-bosi* | Steiner | 1924 |
| | | *Ditylenchus dipsaci* | Wilson | 1948 |
| | | *Meloidogyne* sp. | Steiner & Buhrer | 1933 |
| | | *Rotylenchulus reniformis* | Linford & Yap | 1940 |
| | *P. drummondii* Hook v. *cuspidata* | *Ditylenchus dipsaci* | Wilson | 1930 |
| | *P. drummondii* Hook v. *nanacompacta* | *Ditylenchus dipsaci* | Wilson | 1930 |
| | | *Meloidogyne* sp. | Goff | 1936 |
| | *P. Paniculata* L. | *Aphelenchoides fragariae* | Crossman & Christie | 1936 |
| | | *Ditylenchus dipsaci* | Nypels | 1898 |
| | | *Meloidogyne* sp. | B.C. & S. | 1933 |

TABLE 1 (continued)

Lists of reported nematodes and host plants

| Host | | Nematodes | | |
|---|---|---|---|---|
| Common Name | Botanical Name | Nama | Reported by | Year |
| | *P. sibirica* | *Meloidogyne* sp. | Ustinov | 1939 |
| | *Phlox* sp. v. *amain macha* | *Aphelenchoides subtenuis* | Crossman & Christie | 1936 |
| | *Phlox* sp. | *Pratylenchus penetrans* | Sher & Allen | 1953 |
| | *P. subulata* L. | *Ditylenchus dipsaci* | Steiner & Buhrer | 1933 |
| | *P. suffruticosa* vent, 2 v.s. | *Ditylenchus dipsaci* | Wilson | 1930 |
| 12. Rose | *Rosa* sp. | | | |
| (Rosaceae) | *Rosa blanda* Ait. | *Meloidogyne* sp. | Altstatt | 1942 |
| | *R. chinensis* Jacq. | *Meloidogyne* sp. | Bessey | 1911 |
| | *R. indica* L. | *Meloidogyne* sp. | Park | 1934 |
| | *R. laevigata* Michx. | *Meloidogyne* sp. | Bessey | 1911 |
| | *R. multiflora* Dum. cours | *Meloidogyne* sp. | Altstatt | 1942 |
| | *R. odorata* sweet | *Meloidogyne* sp. | Steiner & Buhrer | 1936 |
| | *R. setigera* Michx. | *Meloidogyne* sp. | Bessey | 1911 |
| | *Rosa* sp. | *Meloidogyne* sy. | Halsted | 1891 |
| | | *Pratylenchus vulnus* | Sher & Allen | 1953 |
| | | *Xiphinema diversicaudatum* | Schindler | 1954 |
| | *Rosa* sp. v. Gloria di Roma | *Ditylenchus dipsaci* | Calvino | 1950 |
| | *Rosa* sp. vs. Hadley | *Pratylenchus pratensis* | Crossman & Christie | 1937 |
| | White Killarney | | | |
| 13. Snapdragon | *Antirrhinum* sp. | | | |
| (Scrophulariaceae) | *A. coulterianum* Benth. | *Meloidogyne* sp. | Buhrer | 1938 |
| | *A. glandulosum* Lindl. | *Meloidogyne* sp. | Buhrer | 1938 |
| | *A. majus* L. | *Aphelenchoides ritzema-bosi* | T. Goodey | 1940 |
| | | *Heterodera rostochiensis* | Holmes-Smith in T. Goodey | 1940 |
| | | *Meloidogyne arenaria* | Tarjan | 1952 |
| | | *Meloidogyne hapla* | Tarjan | 1952 |

TABLE 1 (continuen)

Lists of reported nematodes and hot plants

| Host | | Nematodes | | |
|---|---|---|---|---|
| Common Name | Botanical Name | Nema | Reported by | Year |
| | | *Meloidogyne incognita* | Tarjan | 1952 |
| | | *Meloidogyne incognita* v. *acrita* | Tarjan | 1952 |
| | | *Meloidogyne javanica* Trajan | Tarjan | 1952 |
| | | *Meloidogyne* sp. | Bessey | 1911 |
| | | *Pratylenchus penetrans* | Sher & Allen | 1953 |
| | *A. nuttallianum* Benth. | *Meloidogyne* sp. | Buhrer | 1938 |
| | *Antirrhinum* sp. | *Meloidogyne* sp. | Buhrer | 1938 |
| *14.* Tulip | *Tulipa* sp. | | | |
| (Liliaceae) | *T. gesneriana* L. Cult v.s. | *Ditylenchus dipsaci* | Bos | 1906 |
| 15. Violet | *Saintpaulia* sp. | | | |
| (Violaceae) | *S. ionantha* Wendl | *Aphelenchoides fragariae* | Osterwalder | 1900 |
| | | *Aphelenchoides ritzema–bosi* | Lindhardt | 1952 |
| | | *Meloidogyne* sp. | Tarjan & Cox | 1948 |
| | | *Meloidogyne* spp. | Tarjan | 1951 |
| | | *Pratylenchus* sp. | Tarjan | 1951 |
| | | *Pratylenchus* spp. | Tarjan | 1951 |
| 16. Zinnia | *Zinnia* sp. | | | |
| (Compositae) | *Z. elegans* Jacq. | *Aphelenchoides besseyi* | Sher | 1954 |
| | | *Aphelenchoides fragariae* | Halsted | 1890 |
| | | *Aphelenchoides ritzema–bosi* | Fukushi & Saito | 1930 |
| | | *Meloidogyne* sp. | B.C. & S. | 1933 |
| | | *Paratylenchus macrophallus* | Steiner | 1924 |
| | | *Rotylenchulus reniformis* | Linford & Yap | 1940 |
| | *Z. haageana* Regel | *Aphelenchoides ritzema–bosi* | Junges | 1938 |
| | *Z. pauciflora* L. | *Meloidogyne* sp. | Parris | 1940 |
| | *Zinnia* sp. | *Aphelenchoides fragariae* | Anon. | 1952 |
| | | *Meloidogyne* sp. | Buhrer | 1938 |

Courtney *(5)* recommended the hot water treatment method similar to that advocated by Smith *(23)* except that he recommended pre-soaking the bulbs for 2 hours at 75 F. The proper temperature according to him is 110F for Narcissus and Irises.

*2. Chemical control.* Plant sprays are common practice for chemical control. Successful controls of the foliar nematode on many ornamental plants have been reported. Parathion at the rate of 1/4 to 1/2 pound per 100 gallons of water and sodium selenate are recommended as effective control of foliar nematode caused by *Aphelenchoides ritzema-bosi*, on Chrysanthemum *(16)*.

### *Chemical Soaking*

The corms, tubers or bulbs of some ornamental plants are successfully treated by chemical soaking. Winstead and Skotland *(30)* found in their experiments soaking Narcissus bulbs and gladiolus corms, that sodium 2, 4, 5, trichlorophenoxide at a concentration of 3 lbs per 100 gallons of water for 15 minutes or 2 lbs per 100 gallons of water for 1–2 hours was lethal to the eggs and larvae of *Heterodera glycines*.

### *Soil Treatment*

*1. Soil fumigation.* The soil fumigation has shown to be an effective control of nematodes causing diseases of many ornamental plants, particularly those nematodes attacking underground parts. This method can be applied in greenhouse as well as under field conditions. Complete control depends on other environment, such as soil temperature, water, field capacity and aeration. Soil fumigation should not be attempted at soil temperature below 50F or above 70F. Under field conditions fumigation may have to be repeated once every year or every two years depending upon the build-up of nematode population after treatment.

Slootweg (*22*) found Dichloropropene-dichloropropane (*D–D*), at 42 ml per sq meter, to be the most satisfactory in controlling the root lesion nematode on Narcissus.

Magie and Cowperthwaite (*14*) recommended row application of D.D. and ethylene dibromide (*E.D.B.*) two weeks before planting gladiolus, at the rate of 1/2 pint per 100 feet.

*2. Soil sterilization.* In order to eradicate the parasitic nematodes, soil sterilization by steam is commonly used under greenhouse conditions, especially in the florist commercial greenhouses. The time and pressure recommended for sterilization are 4 hours and 15 pounds.

Selby (*18*) recommended sterilization of composted soil used for ornamental plants in greenhouses to eradicate the parasitic nematode.

*3. Summer fallowing.* Keeping unfavorable conditions for the nematodes for a period of time can reduce considerably the population of parasitic nematodes in infested soils.

Magie and Cowperthwaite (*14*) recommended, in gladiolus plantings, plowing the soil and allowing the sun to dry and heat the soil during 3 weeks disking the soil twice each week.

### *Resistant Varieties*

It has been reported that some varieties of peach, grapes, limabeans and walnuts are resistant to some particular nematode species (*16*); but so far no available reference was found on resistant varieties of flowering ornamental plants.

### *Sanitation*

This practice includes such operations as removal and destruction of infected plants and prevention of contamination from material that is already infected.

Courtney (*5*) described sanitation for controlling nematodes in bulbs of some

flowering ornamental plants by destroying the infected material by, for instance, removing infested debris and spraying tools with formalin.

*Cultural Methods*

These methods are only for ornamental plants grown under field conditions. The most appropriate method would be perhaps crop rotation. In order to plan an adequate crop rotation, the knowledge of the host range and the specific nematodes present is very important.

Magie and Cowperthwaite (*14*) recommended 3 year crop rotation for control of the root–knot nematode in commercial fields of gladiolus in Florida.

Spacing between plants growing in the field seems to be important regarding spread of foliar parasitic nematode by leaf contact. In the case of Chrysanthemum, as well as other plants, the increasing space of planting helps to prevent the spread of *Aphelenchoides ritzema–bosi* from plant to plant.

Roguing is also one of the common practices of control particularly for foliar nematode. Cutting of infected foliar parts is also recommended for Chrysanthemums attacked by *Aphelenchoides ritzema–bosi* (*16*).

SUMMARY

The review first stresses history and the importance of nematode diseases on some flowering ornamental plants such as Aster, Chrysanthemum, Narcissus, Tulip, Gladiolus, Begonia, etc., and, in brief, mentions the activity of the more important nematodes such as *Aphelenchoides*, *Ditylenchus*, *Pratylenchus*, and *Meloidogyne* which infect many of the ornamental plants.

The nematode parasites of various common flowering ornamental plant are described with biology of disease, source of infection, conditions favorable to the disease, symptoms and pertinent literature. The flowering ornamental plant included are : Aster, Bagonia, Carnation, Chrysanthemum, Dahlia, Gladiolus, Hyacinth, Iris, Narcissus, Petunia, Phlox, Rose, Snapdragon, Tulip, Violet and Zinnia.

Control methods which includes treatment of plant parts, chemical and non–chemical control, soil treatment, resistant varieties, sanitation, and cultural methods are briefly described.

เรื่องย่อ

บทความนี้ได้รวบรวมความรู้เกี่ยวกับไส้เดือนฝอยที่ทำลายไม้ดอกไม้ประดับบางชนิดจากเอกสารวิจัยค้นคว้าในต่างประเทศ และตั้งใจเจาะจงเลือกกล่าวเฉพาะไส้เดือนฝอยใน genus ที่ทำความเสียหายมาก เช่น *Aphelenchoides*, *Ditylenchus*, *Pratylenchus*, และ *Meloidogyne* โดยกล่าวถึงชีววิทยา แหล่งที่จะติดเชื้อ สภาพสิ่งแวดล้อมที่เหมาะสมกับการระบาดของโรค ตลอดจนลักษณะอาการที่แสดงออกให้เห็นกับไม้ดอกบางชนิด รวมทั้งวิธีป้องกันกำจัดที่ได้ผลดี

ผู้เขียนหวังอยู่ว่าเอกสารนี้นี้ จะเป็นประโยชน์ต่อผู้นิยมเล่นไม้ดอกไม้ประดับบ้างตามสมควร

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