

## The Golden Nematode of Potatoes (*Heterodera rostochiensis* Woll., 1923)—a threat to potato cultivation in the Nilgiris (Madras State)\*

by

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**Synopsis:** The golden nematode of potatoes (*Heterodera rostochiensis*) was reported for the first time in India from the Nilgiris (Madras) in 1961 by Jones. Recent surveys conducted in the Nilgiris have shown that infestation is mainly confined to the Ootacamund area. The appearance of this nematode in the Nilgiris constitutes a threat to potato cultivation in that area. Written mainly with the object of focussing public attention on this important problem, the article provides basic information about the nematode and its life history, the symptoms of the disease caused, methods of detecting infestation, methods of spread, alternate hosts and methods of preventing spread. No practical control measure is known against the pest and unless immediate and effective steps are taken to check its spread, potato cultivation in the Nilgiris is bound to become increasingly difficult in the years to come.

The golden nematode of potatoes (*Heterodera rostochiensis* Wollenweber, 1923) has long been known to be one of the most serious problems encountered in potato cultivation in temperate regions of the world. Originally described by Wollenweber in 1923 from specimens found in the vicinity of the city of Rostock, Germany, this nematode now enjoys a very wide distribution in most of the potato growing countries of the world. Apart from most European and Mediterranean countries and the British Isles, it occurs in some parts of South America, in Long Island, New York in North America and in Japan. According to Thorne (1961) the original source of the pest may possibly be Peru, the home of potatoes, from where the nematode was reported by Bazah de Segura in 1952.

Recently the golden nematode has been reported for the first time in India, in the Ootacamund area of the Nilgiris by Jones (1961) who found a lightly infested field at an elevation of over 7,000 ft. above sea level. An earlier report by Sen (1960) indicated the possibility of the presence of this pest in Ranchi District of Bihar, but the identity of the nematode was not positively confirmed. † It is not known when this nematode gained entry

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† Since submitting this article for publication, the authors have seen a report on the occurrence of the golden nematode of potatoes at the Indian Agricultural Research Institute Farm, New Delhi (Prasad, S. K. & D. R. Das Gupta, *Indian J. Ent.* 23 (3): 239-40).

to this area, but quite possibly this might have been introduced several years ago along with imported potato seed material from Britain or one of the European countries.

Since the formation of the Nematology section at the Agricultural College and Research Institute, Coimbatore in October, 1961, regular random surveys of the main potato growing areas around Ootacamund, Nanjanad, Coonoor and Kotagiri have been in progress, both by soil sampling and by root examination of the standing crops. Varying degrees of infestation by the golden nematode, ranging from light to heavy, have been noted in several fields mainly in the Ootacamund area. Further survey work is in progress and is likely to reveal fresh pockets of infestation. The appearance of the golden nematode of potatoes in the Nilgiris is a serious threat to potato cultivation in that area. No practical control measure is known against this pest in spite of years of intensive research in several countries and unless immediate steps are taken to check its spread, cultivation of potatoes in the Nilgiris will become increasingly difficult, if not almost impossible in the years to come.

A great deal of research has been done on the golden nematode of potatoes by workers in different countries and the number of publications on this subject run to several hundreds. Comprehensive reviews and lists of such publications have been given by Oostenbrink (1950), Franklin (1951), Ichinohe (1961) etc. The present article is written with a view to focus attention, especially of all those connected with potato cultivation in this country, on this important problem and to provide basic facts about this nematode to the public who may not have easy access to the mass of scientific literature that is available on the subject.

**Symptoms of the Disease:** The disease caused by this nematode is often referred to as "potato sickness". The symptoms of the disease are not very clear cut and this makes it somewhat difficult to detect infestation by the general appearance of the crop, especially when there is the incidence of late blight and other diseases also in the field. The presence of the golden nematode is often not noticed until the pest has been present in the soil for a number of years. This is because lightly infested crop does not show any above ground symptoms at all. When the infestation is sufficiently heavy and localised, small patches of poorly growing plants appear in the field; wilting may occur during hot parts of the day. In fact this is often the first evidence above ground of the presence of the golden nematode. More evenly distributed infestations may cause a sudden failure of crops in whole fields (Fig. 1). Repeated cultivation of potatoes encourages the rapid multiplication and build-up of the parasite. Heavily

attacked plants remain severely stunted with dull and unhealthy looking foliage. As the season advances, the lower leaves turn yellow and brown and wither, leaving only the young leaves at the top, the entire plant now presenting a somewhat "tufted head" appearance. The browning and

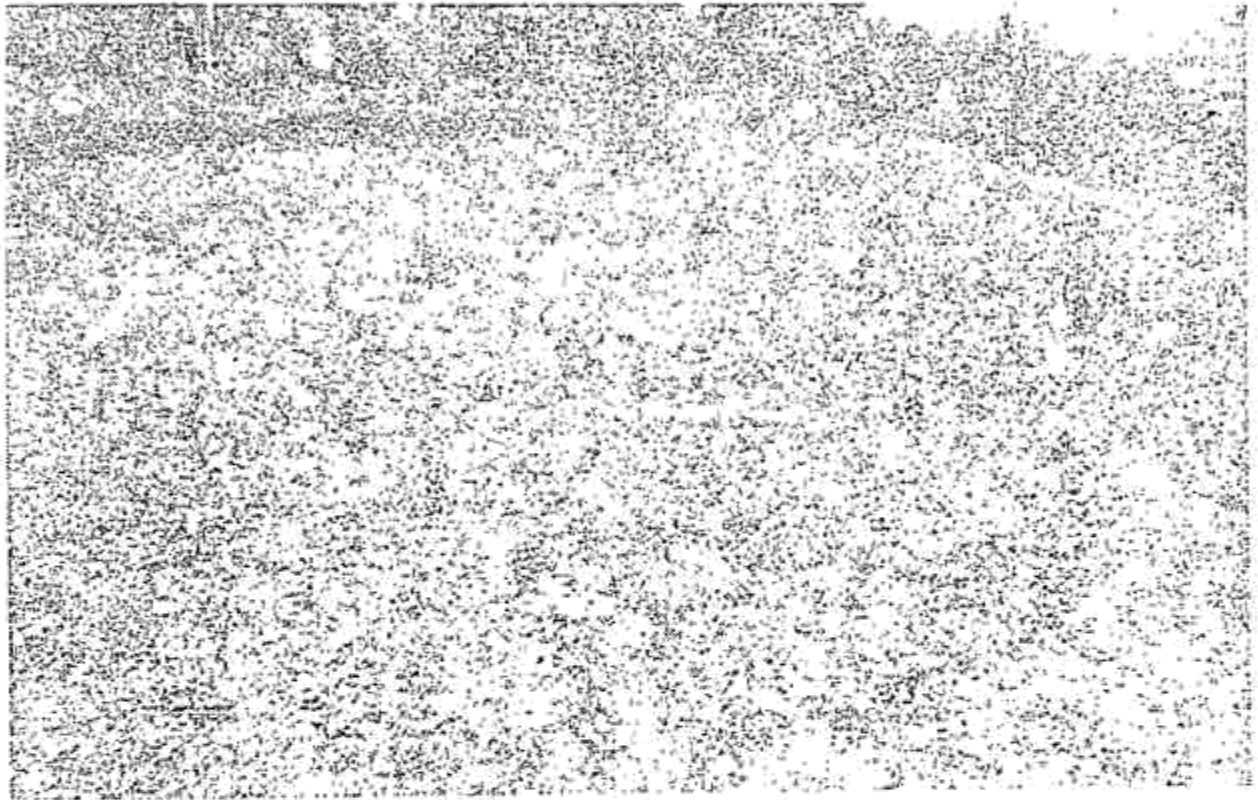


FIG. 1.

A 2½ months old potato field in Ootacamund badly infested by the golden nematode. Late blight was also present.

withering of the foliage gradually extends and ultimately causes the premature death of the plant. The root system is poorly developed and the yield and size of the tubers are reduced considerably depending upon the degree of infestation. Badly infested plants give little or no harvest. Symptoms may vary from year to year, depending on growing conditions and fluctuations in populations of the nematode.

**Life History of the Golden Nematode:** This nematode has an interesting life cycle. Plants from an infested field when pulled out and examined will often show clusters of white and golden coloured spherical bodies, about the size of a sand grain, attached to the roots and tubers (Fig. 2). These are the mature females of the golden nematode and they generally appear on the root surface when the potato crop is about 2 to 3 months old. The swollen body of the nematode is filled with hundreds of eggs. When fully mature the white body of the female gradually changes to a golden colour and finally to dark brown. The body wall of the nematode has now become

a "cyst" (Fig. 3). Due to the disturbance caused to the roots at the time of harvest, the cysts get dislodged and drop down into the soil and remain dormant until the next potato crop is planted. In other words it is through the cyst stage that the animal passes over from one crop to another defying all adverse conditions. Heavily infested soil usually contains several millions of these cysts per acre.

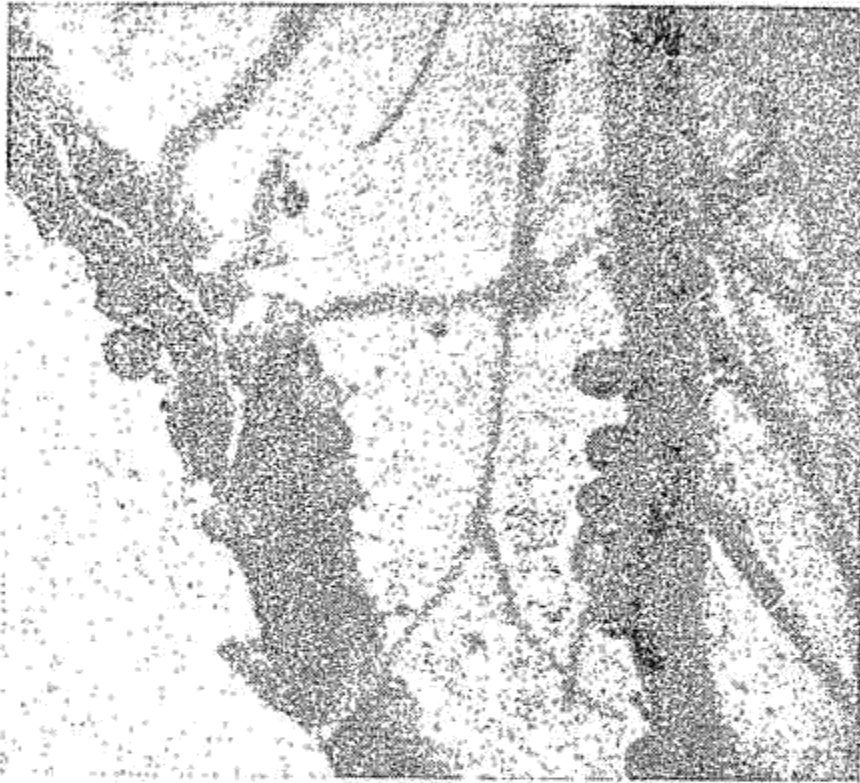


FIG. 2.  
Swollen white females of the golden nematode attached to potato roots.

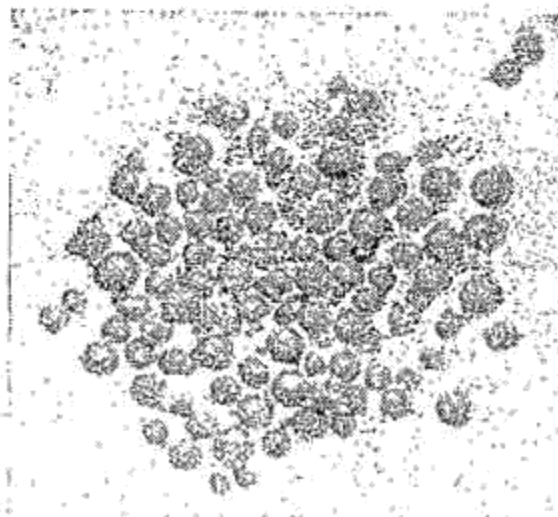


FIG. 3.  
Golden nematode cysts.

A newly formed cyst usually contains 200-600 eggs (Fig. 4). A chemical substance contained in the root exudate of the potato plant (or other suitable alternate host) is necessary to stimulate hatching of the eggs. Thus, when the next potato crop becomes available, the tiny larvae



FIG. 4.

Microphotograph of a crushed cyst of the golden nematode to show the eggs inside. Some II stage larvae have come out of their egg shells while crushing the cyst.

second stage) hatch out from the eggs, leave the cyst through a minute opening and move through the soil towards the potato roots. Both male and female larvae enter the roots usually near the root tip and feed with their heads directed towards the conducting tissues. During the life cycle the larvae undergo four moults, the first moult being inside the egg and the remaining three within the host root.

The males when mature are long and thread like and measure about .0 mm. in length. They leave the root and move about in the soil in search of the females. The females, on the other hand, are sedentary and with each moult becomes enlarged and swollen. As they grow they exert pressure on the surrounding root tissue and finally break through the cortex to the outside, remaining attached to the root only by the neck and head. Soon fertilization by the male takes place and eventually the female wells up further due to the enlargement of the uterus, becoming almost spherical. It is at this stage that the pest is visible to the naked eye as the white females and cysts attached to the roots.

The life cycle requires about five to seven weeks depending on moisture, temperature and other factors. Only one generation is normally produced every year. Soil temperatures of 60°-65°F. seem to be ideal for the pest, no development taking place when this goes up to 85°F. or more. Soil pH does not appear to have any influence on the nematode and its development. Soil types may have some influence; several workers consider that the golden nematode generally reduces potato yields more on light sandy soils than on heavier soils. The disease symptoms are reported to be more severe in dry years than during a year with normal rainfall, though reduction in yield did not show much difference. Tests conducted in Long Island have shown that more golden nematodes developed on potato roots in plots receiving regular irrigation than in non-irrigated plots (Mai and Harrison, 1959).

**Methods of Detecting Infestation:** The white females and cysts of the golden nematode of potatoes are easily recognizable from other species of cyst-forming nematodes because of their spherical shape and certain other morphological characters. There are two methods of detecting infestation in a field. An easy way to detect the presence of the nematode in the soil is by examining the roots of the potato plants and looking for the white females or cysts. However the white females appear on the surface of the roots only for a short period during its life cycle, i. e., when the crop is about two to three months old. After this period they change into the brown cysts when they are no longer easily detected against the dark colour of the soil. In searching for this nematode by this method, the soil around the plants should be loosened with a hand shovel or digging fork, the plant should then be lifted along with the soil around the roots and the roots examined preferably with a hand lens after carefully removing the soil. Sufficient number of plants have to be examined and special attention should be given to poor patches of the crop.

The second method of detecting infestation which is more foolproof is by soil examination for the presence of cysts. This can be done at any time of the year when the land is fallow or even when there is some other crop in the field. Random soil samples from several locations in the field are collected with a small hand shovel or spoon from any depth up to eight inches; these are then mixed together to form a composite sample from which suitable aliquots are drawn and cysts recovered. Recovery of the cysts is usually done by a flotation technique which utilises the fact that when dried soil is thoroughly mixed in water the cysts of the nematode, which are lighter than soil particles, float and can therefore be easily separated.

The routine examination of the roots of potato plants and soil sampling are the only practicable and sure methods of determining the presence and degree of soil infestation. Soil sampling is generally preferred in all planned surveys in many countries.

**Methods of Spread:** Golden nematodes are spread from place to place, not by their own efforts, but by the movement of infested soil in various ways. Over short distances the cysts are carried about in the soil adhering to ploughs and other farm implements during agricultural operations, on the bodies of men and animals working in the farm, on the harvested tubers and on gunny bags and other containers used for collecting and storing potatoes. The cysts may also be spread by wind and rain water. Dust storms may carry the cysts over long distances. Planting seed potatoes grown in infested land and raising nurseries of cabbage, cauliflower etc., in an infested field and transplanting them elsewhere often lead to fresh infestations.

Infested soil adhering to seed potatoes plays an important part in spreading the nematode over long distances. In fact there is little doubt that this nematode has gained entry to the Nilgiris only by this method.

**Other Hosts:** This nematode is known to have certain host preferences. Apart from potatoes which serve as the main host, tomatoes and brinjal are highly susceptible among the cultivated crops. Other plants including weeds belonging to the potato family (Solanaceae) may also serve as hosts. Outside this family the flowering plant snapdragon (*Antirrhinum majus*) which is widely grown in the Nilgiris is also susceptible.

**Control:** Control of this nematode is particularly difficult because of the fact that the nematode can persist in the soil for several years in the absence of the host plant. The eggs inside the cysts have been known to retain their viability for nearly 15 years. Chemicals used to control other pests are of little use against this nematode because of the highly resistant cysts. There is experimental evidence to prove that soil fumigation with modern nematicides may kill over 90% of the larvae inside the cysts, but only at extra heavy dosages of the chemicals (DD, Methyl Bromide) which makes the operation prohibitively expensive even in countries like the U. S. A. Further, even if this is done, the small percentage of the surviving worms multiply rapidly if and when a potato crop is planted again. Thus it may be seen that there is no practical control measure known which will give satisfactory results in eradicating the pest when once the land becomes infested.

The following are some of the measures which should be adopted to prevent the spread of infestation :

(i) Potatoes, tomatoes, brinjal and chillies should not be grown in fields known to be infested by the golden nematode. Crops other than the above may be grown.

(ii) Volunteer potato seedlings should not be allowed to come up in infested fields.

(iii) Many fields may carry light infestation and it may take a long time before this is detected. Therefore as a matter of precaution crop rotation should be adopted regularly in all potato growing areas where this nematode has not been detected. Potato should be grown only once in four years or more as per the accepted practice in many countries. The longer the rotation, the lesser the risk of nematode trouble. Tomatoes, brinjal and chillies should not be included in the rotation.

(iv) Vegetable nurseries and other plants meant for transplanting (e. g., cabbage, cauliflower, snapdragon etc.) should not be raised on infested land as this will lead to spread of infestation.

(v) Potatoes grown in infested soil should not be used for seed purposes as this is a sure way of spread. No satisfactory method of disinfecting potato tubers by means of chemicals is known.

It may be said in conclusion that though the infestation in the Nilgiris appears to be generally light at present, there is every possibility of the nematode spreading and increasing in virulence in the years to come. The Agricultural Department is taking every possible step to detect all pockets of infestation with a view to prevent further spread of the pest, but the co-operation of the potato-growers is absolutely essential in combating the menace and checking its spread.

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