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CYST NEMATODES IN MEXICO, CENTRAL AND SOUTH AMERICA

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Although geographically a part of North America, Mexico has been included together with Central and South America in this discussion of cyst nematodes because its agricultural and cultural conditions, as well as its climate, are more similar to the latter regions than to the rest of the North American continent.

Most of the countries in the group are located from approximately 30°N to 60°S and, consequently, are considered tropical and have warm weather. However, the high elevation of the Andes in South America and the mountain ranges of Central America and Mexico provide cold areas appropriate for growing potatoes, grains and other temperate crops. Thus in such areas the range of climate conditions allows many species of cyst nematodes to exist and populations may increase to levels which cause damage to crops.

Potato cyst nematodes

Lack of trained nematologists and financial resources has limited, until recently, the development of nematological research in Latin America. The first identification of a cyst nematode in this part of the world is probably that of Bazan de Segura (1952), who reported the golden nematode (*Globo-*

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dera rostochiensis Behr.) in Peru (Martin, 1963). This remained as an isolated record until 1967 when the golden nematode was recorded in Panama (Espinosa, pers. comm.). The species was believed to have been introduced into Chile in 1967 (Schalf, 1979) but this was not confirmed officially until 1973 (Anonymous, 1978; Valenzuela, 1979; Ocampo, 1979; Jimenez and Gallo, 1982; Herrera, 1985; Gallo, pers. comm.).

In Venezuela, Colombia and Mexico *G. rostochiensis* was not recorded until 1971 (Sosa-Moss, unpublished; Iverson, 1972; Anonymous, 1973; Monroy, pers. comm.; Guerrero, pers. comm.) and in other Latin American countries it has not yet been recorded although its presence is likely, as in the case of Argentina (Costilla, pers. comm.).

Such findings have stimulated research on potato cyst nematodes although information about them is still very limited.

The two species *G. rostochiensis* and *G. pallida* considered part of the «Golden Nematode Complex», are the most common cyst nematodes in the temperate areas of Latin america. Peru and Bolivia are accepted as their centre of origin and the distribution of the two species in other Central and South America countries is the result of dispersion of native populations, or the introduction from European countries with seed potatoes (Spears, 1968). In general, in Chile and Venezuela in South America, Costa Rica and Panama in Central America and in Mexico, the golden nematode has been introduced and is represented by *G. rostochiensis*. In Bolivia, Peru, Ecuador and Colombia it is considered that the endemic species is *G. pallida* (probably of local origin) rather than *G. rostochiensis* (Evans *et al.*, 1975; Franco, 1981). The presence of *G. pallida* in Chile was suspected by Moreno and Parraguez (1983) and recently confirmed by Moreno *et al.* (1985). The distribution of these two species in Latin America is shown in figures 1 and 2.

Both species are economically important in the countries where they have been recorded. In heavily infested soils, in countries such as Ecuador, Colombia, Peru and Mexico where assessment has been made, reduction of yield ranges between 15 and 90% of tubers production (Rodriguez and Sosa-Moss, 1973; Fernandez and Guglieminetti, 1985; Guerrero, pers. comm.; Revelo, pers. comm.; Franco, pers. comm.). Losses are higher when other plant pathogenic organisms, such as *Pseudomonas solanacearum*, are present in the same field (Camacho and Sosa-Moss, 1980). The importance of the golden nematode complex in Latin America may be judged from the extensive areas dedicated to the cultivation of potatoes e.g. Mexico 70,000 hectares, Ecuador 33,500 hectares where very few fields are free from infestation (Herrera, 1985; Sosa-Moss, unpublished; Revelo, pers. comm.).

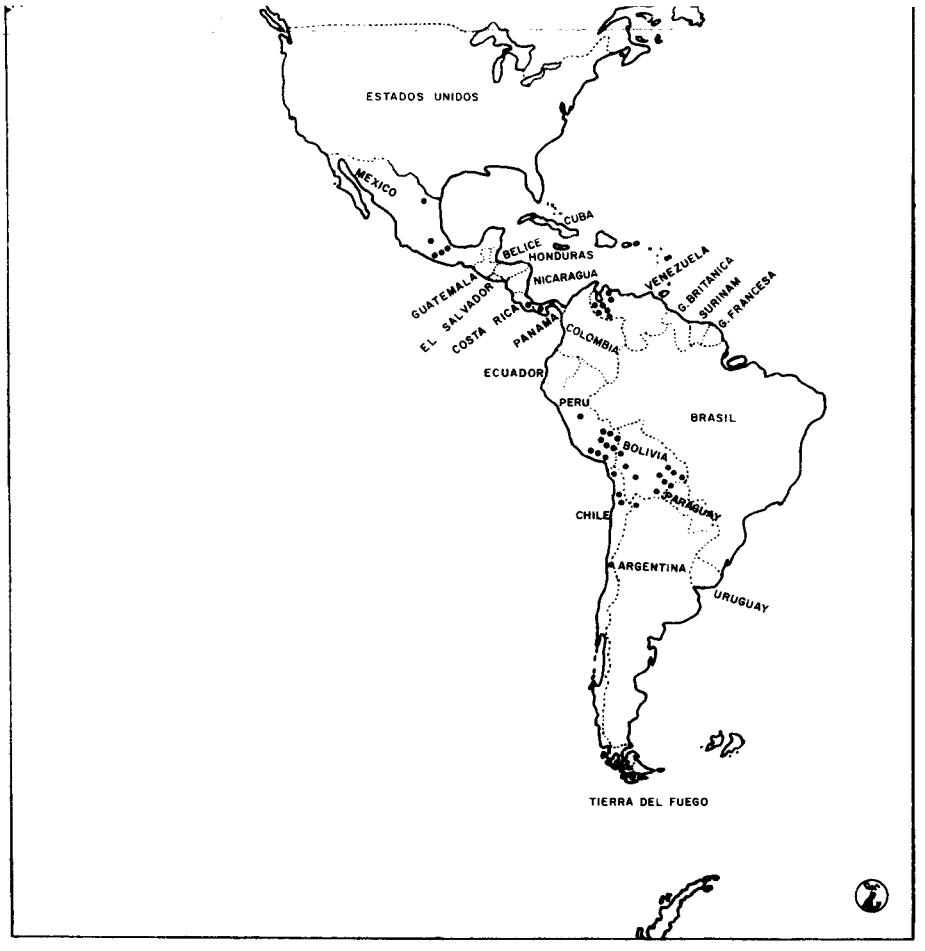

Fig. 1 - Distribution of *Globodera rostochiensis* in Latin American countries; records until 1985.

In many of the other countries similar areas of potatoes are cultivated. In all of the countries potatoes are an important part of the daily diet.

Due to the recent discovery of the golden nematode in Latin America, research on its distribution in the various countries is still in progress and survey programmes are being pursued actively. Each year new potato growing areas previously considered free of this pest are found to be infested and are then subject to the necessary quarantine measures (Anonymous, 1976; Anonymous, 1978; Ocampo, 1979). Consequently, conflict between potato growers and quarantine agencies has been gener-

Fig. 2 - Distribution of *Globodera pallida* in Latin American countries; records until 1985.

ated and few advances in the knowledge and solution to the problem have been obtained. This is one of the reasons why only in countries such as Peru, Bolivia, Ecuador, Chile and Mexico that the species and races of cyst nematodes have been identified. Thus, Rodriguez and Sosa-Moss (1973) identified the actual R_1A pathotype in Mexico and in accord with Franco (pers. comm.) consider this the common one in other countries of Latin America. The distribution of races of *G. pallida* in these countries is summarized in Table I according to the data of Franco (unpublished).

The technology of chemical control, as developed in countries where the golden nematode is an old problem, has been applied with success in

Table I - *Pathotype identification of the potato cyst nematode* G. pallida *Stone*

POPULATIONS	PATHOTYPES					
	P_1B	P_2A	P_2B	P_3A	P_4A	P_5A
Bolivia			+	+	+	
Peru	+	+		+	+	+
Ecuador		+		+	+	
Colombia		+		+	+	

Latin America. However, because of the activity of the international chemical companies, nematicides have tended to be recommended indiscriminately (Gomez, 1973; Camacho *et al.*, 1977; Santamaria and Teliz, 1984; Guerrero, pers. comm.; Revelo, pers. comm.) although because of their high cost in Latin America their use is profitable in only a few areas.

Other control measures such as crop rotation and resistance are also being investigated in Chile, Peru, Colombia, Ecuador, Venezuela, Panama and Mexico. Crop rotation seems to be very useful, but there is still not enough information available to formulate recommendations for large areas (Meredith, 1976; Bautista and Rodriguez, 1979). To use resistant cultivars it is imperative to identify the races of *G. rostochiensis* or *G. pallida* before starting any programme. Resistant genotypes selected in other countries could be used in Latin America, but it would perhaps be more useful to identify genes for resistance in local potato material (Fernandez and Guglielminetti, 1985). In this regard, the International Potato Center (CIP) at Lima, Peru, has an ambitious project for potato selection and hybridization. Promising material from CIP is sent to the various countries for testing against the species and pathotypes present (Franco, pers. comm.).

Biological control of the golden nematode has been initiated in Latin America with research on *Paecilomyces lilacinus* in some countries. This fungus, which destroys the eggs of root-knot nematodes (*Meloidogyne* spp.) seems to be effective against potato cyst nematodes. However, the cost of field inoculations makes the use of this biocontrol impractical for the present (Revelo, pers. comm.; Santamaria, pers. comm.).

In relation to the golden nematode problem in Latin America, it is important to note that at least in Mexico three other species of *Globodera* are frequently interspersed with *G. rostochiensis* in potato fields. These are *G. tabacum*, *G. solanacearum* and *G. virginiae* (Becerra and Sosa-Moss,

1976) which could erroneously be identified as the golden nematode. Also in Mexico, several populations of *Globodera* similar to but not *G. rostochiensis* nor *G. pallida* have been detected in association with non-cultivated tuber bearing solanaceae, including wild potatoes in the genus *Solanum*. This demonstrates the wide distribution of *Globodera* in the mountains of Latin America, and the genetic variability in the genus (Miller, 1977; Miller, 1983; Stone, 1977; Stone, 1983). These local populations do not reproduce in *Solanum tuberosum* but can be a source of error in routine survey analyses, and could also be a potential hazard for other cultivated solanaceae. Further investigation is required in order to elucitade the taxonomic status of these cyst nematodes.

A *Globodera* species very similar to the golden nematode was found in Mexican soils in 1963 by Sosa-Moss and described by Campos Vela in 1967 as *Heterodera mexicana* (now *G. mexicana*). However, the description was incomplete and therefore the species remains as «inquirenda». Other *Globodera* spp. with non solanaceous plants as hosts have been observed in Peru (Jatala *et al.*, 1979).

Mexican corn cyst nematode

After the potato cyst nematodes, the «Mexican Corn Cyst Nematode» is the next economically important cyst nematode in Latin America. The species is now included in the genus *Punctodera*, but when it was discovered in 1961 it was identified as *Heterodera punctata* (Sosa-Moss, 1965). Detailed morphological observations made by Villanueva and Sosa-Moss (1974), indicated that the Mexican population of this nematode was different from the species described by Thorne (1928) on wheat in Saskatchewan, Canada, and also from the English population recorded by Franklin in 1938 and 1949 on the roots of *Agrostis stolonifera* and *A. tenuis*. For this reason it was referred to as the «Mexican race of *Heterodera punctata*» and it was not until 1977 that the nematode was formally described as *Punctodera chalcoensis* (Stone *et al.*, 1976).

Punctodera chalcoensis is widely distibuted and causes severe damage in corn fields in the upland valleys of Central Mexico, especially in the states of Mexico, Puebla and Tlaxcala (Vasquez, 1976; Talavera and Sosa-Moss, 1976). Recently, it has been reported in several other corn-growing areas of the country (Sosa-Moss, unpublished). Under certain conditions, especially when some pathogenic fungi are present, the nematode may significantly reduce (up to 90%) the yield of corn, and the plants remain

so stunted and yellow that no straw can be harvested (Becerra and Sosa-Moss, 1978). In general, later sown corn suffers greater damage because the peak emergence of infective juveniles of *P. chalcoensis* occurs at the same time as seed germination. Early sown corn has already developed a good root system before the rains provide sufficient moisture to stimulate hatching of the juveniles. So far, corn (*Zea mays*) and its ancestor «teozintle» (*Zea mexicana*) are the only two host plants from among the many plants tested known to be attacked by *P. chalcoensis* (Stone *et al.*, 1976; Sosa-Moss, 1977). It has been shown that corn root exudates stimulate the hatching of this nematode to a greater extent that those of non-host plants (Villanueva and Sosa-Moss, 1974; Muñoz and Sosa-Moss, 1983).

Punctodera chalcoensis has only one generation per year and a period of hibernation is required to break diapause and stimulate the emergence of the infective second stage juveniles in the following spring. Its life cycle is similar to that of the other cyst nematodes, and is completed in approximately fifty days under experimental conditions. The males mature earlier than the females, emerge from the host root, then move to the females and mate with them. Eggs are produced after fertilization and are retained in the cyst body; no egg masses are produced (Becerra and Sosa-Moss, 1978; Muñoz and Sosa-Moss, 1983).

The females of *P. chalcoensis* form spherical cysts very similar in shape and even in colour to those of *G. rostochiensis*; they can be distinguished from *P. punctata* whose cysts are pear-shaped or elongated. In Mexico, it is important to keep the similarity in shape of the cysts of these two species in mind, because both occur in cold areas where corn and potatoes are grown (Becerra and Sosa-Moss, 1976).

The high cost of nematicides generally precludes their use for the «Mexican Corn Cyst Nematode». However, microdoses of systemic nematicides applied to the corn seeds have been tested and some improvements in yields have been observed (De Santiago *et al.*, 1984; De Santiago *et al.*, 1985). Crop rotation could be a good control method because of the nematode's restricted host range, and particularly because teozintle does not represent a significant risk because it is not cultivated and it occurs only as patches of a few plants. Early sowing (late March to early April) is a cultural practice that takes advantage of the period before infective juveniles have hatched. It is important to provide adequate nutrition for early sown crops as poorly fertilized plants are more susceptible to nematode infestation and increase in damage results (Sosa-Moss and Gonzales, 1973). Research on resistance and tolerance to *P.*

chalcoensis has produced some corn hybrids with differences in response to infestation (Hernandez, 1965).

Other species closely related to *P. chalcoensis* have been identified from some cold and temperate areas of Mexico (Sosa-Moss, 1983). These include *P. matadorensis*, originally described in Canada and whose host plants are wild grasses rather than corn. The main differences between this species and *P. chalcoensis* are: the cysts of *P. chalcoensis* are round and those of *P. matadorensis* are subspherical; also bullae between the anal and vulval fenestrae are absent in *P. chalcoensis* (Mulvey and Stone, 1976). However, the most practical feature that differentiates the species is the length of the oesophageal glands in second stage juveniles; in *P. matadorensis* juveniles the glands overlap the intestine so much that they reach almost 50% of the entire body length whereas in *P. chalcoensis* juveniles the glands are of normal size (Stone *et al.*, 1976; Sosa-Moss, 1977).

Other cyst nematodes

Some other cyst nematodes of minor importance have been found in Mexico but no information is available for other Latin American countries. Among these species, *Heterodera schachtii* was identified in 1969 infecting *Beta vulgaris* in Chalco area, close to Mexico City. The nematode was probably introduced in beet seeds, as Mexico does not produce its own seed of this crop but imports from Europe. *H. schachtii* is of negligible economic importance because in spite of the fact that it was discovered in 1969, its populations have remained low and infestations are very localized.

Anoter species of the same group, *H. cyperi*, has recently been recorded in two states of Mexico (Tlaxcala and Nayarit) parasitizing *Cyperus* spp. This plant is a very common weed in cold, temperate and tropical areas and *H. cyperi* could therefore have a wide distribution (Cuevas, pers. comm.; Rodriguez-Blanco, pers. comm.).

Cactodera is represented in Mexico by two species: *C. cactii* registered without a precise description by the USA Department of Agriculture (Mulvey and Golden, 1983), and *C. amaranthii* observed in the central part of Mexico on spinach and other plants; it is also common on some weeds belonging to the familes *Chenopodiaceae* and *Amaranthaceae* (Sosa-Moss, unpublished).

A *Sarisodera*-like species has been found in the central high valleys of Mexico. The nematode has not yet been studied in detail and even its correct taxonomic position is uncertain (Becerra and Sosa-Moss, 1976).

It should be mentioned that in Latin America there are still some countries from which no information concerning cyst nematodes is available. This is so for Central America (with the exception of Costa Rica and Panama), all the Caribbean Islands and Brazil, Paraguay, Uruguay and the Guianas in South America. Some of these countries have cold and temperate areas while others are completely tropical in climate; in either case cyst nematode species should be expected. It is surprising that no tropical species of cyst nematodes, such as *Heterodera oryzicola, H. oryzae, H. sacchari, H. gambiensis, H. indocyperi, H. cajani, H. vigni, H. delvii, H. sorghi* and *H. raskii* have so far been recorded in Latin America.

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