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DISTRIBUTION OF *RADOPHOLUS SIMILIS* IN INDIA, ITS SPREAD IN NEW REGIONS AND AN ANALYSIS OF THE NEMATOFAUNA OF BANANA CROP PATHOSYSTEM

by
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Summary. Random surveys revealed the widespread occurrence of *Radopholus similis* in banana plantations of India, especially in the new plantations of the north eastern states viz. Assam, Bihar, Nagaland, West Bengal and eastern region of Uttar Pradesh. Frequency of occurrence was highest in Nagaland (100) followed by Uttar Pradesh (50), West Bengal (42.8), Bihar (21.7) and Assam (16.6). It was not detected in Meghalya state. Factors involved in the progressive spread of *R. similis* are critically examined and the role of research institutions of the country and progressive farmers in introduction of banana cultivars to new agro ecological zones and the escape channel of the nematode alongwith the cultivars are discussed. Analysis of nematode community also reveals the variable degree of occurrence of coinhabiting nematode fauna viz. *Pratylenchus coffeae, Helicotylenchus multicinctus* and many other nematodes viz. *Meloidogyne* sp., *Hoplolaimus* sp. etc. A range of banana cultivars belonging to AAA and ABB group were infested with varying degrees of population of burrowing nematode i.e. 1-640 and 2-110 specimens per 10 g root respectively.

The burrowing nematode, *Radopholus similis* (Cobb 1893) Thorne 1949 is one of the major constraints to the productivity of banana wherever the crop is grown (Gowen and Quénéhervé, 1990). India is the largest producer of banana in the world, with an annual production of 10.4 million tonnes from an area of 0.4 million ha (Chadha, 1995). Significant economic losses, resulting from *R. similis* infestation ranging from 31 to 41% have been reported (Anon, 1979; Reddy *et al.*, 1992). Since the first report of its occurrence in Kerala (Nair *et al.*, 1966), the area of its infestation has increased progressively over the years. Following its spread to the neighbouring states viz.. Tamil Nadu (Rajgopalan and Chinnarajan, 1976) and Karnataka (Venkitesan, 1976), infestations have been identified in several different geographical regions of the country viz. western part - Maharashtra (Reddy and Singh, 1980) and Gujarat (Sethi *et al.*, 1981); Central - Madhya Pradesh (Tiwari and Dave, 1985), Southern part - Andhra Pradesh (Reddy and Khan, 1987), Western coastal region - Goa (Koshy and Sosamma, 1988). Recently, the nematode has been found in some north eastern states of the country viz. Manipur (Anandi and Dhanachand, 1992), Orissa (Mohanty *et al.*, 1992); Chotanagpur belt of Bihar state (Khan and Kumar, 1993); Tripura (Mukheriee, *et al.*, 1994). Infestations have also been detected in Lakshadweep island (Sundraju, 1995). *R. similis* is also a potential pest of commercially important crops like coconut, arecanut, cardamom and pepper (Koshy *et al.*, 1978) and ornamentals like Jasmine (Khan and Reddy, 1989). Certain north eastern states like Assam, Bihar, Man-

ipur, Meghalya, Orissa, Tripura and Uttar Pradesh contribute 11.3%, 3.3%, 1.1%, 1.4%, 6.5%, 1.2%, 0.2%, respectively, in terms of area (ha) and 8.5%, 1%, 0.4%, 1%, 3.8%, 0.5% and 0.2% in terms of production (tonnes), respectively, (Shanmugavelu *et al.*, 1992). Infestations of the burrowing nematode have also been found in the Orissa and Tripura states. Its polyphagous nature and distribution over a wide range of geographical areas of the country, coupled with the progressive increase in the area under banana cultivation, makes of it a threat to banana and other crops in the northern region especially Bihar, eastern regions of Uttar Pradesh where the banana cultivation is being undertaken on quite a large scale and with further increase likely. A closer scrutiny of the prevalence of *R. similis* in the banana growing regions of Assam, Bihar, Nagaland, Uttar Pradesh and West Bengal is required and is the basis of the present investigation.

Materials and methods

Random surveys were conducted from 1992 to 1997 covering sixteen districts belonging to five states of the north eastern region of the country. A total of 139 samples were collected from commercial banana (triploids of *Musa acuminata* Colla and *M. acuminata/balbisiana*) cultivations (Bhagalpur, Darbhanga, Kathiar, Muzzaffarpur, Samastipur and Vaishali districts in north Bihar, Allahabad district in eastern Uttar Pradesh; Sonitpur district in Assam) as well as non-traditional areas with banana cultivation either on a very small scale or in home gardens (Ranchi and Lohardaga district in South Bihar, Guwhati district of Assam, Midnapur, Murshidabad and 24-Pargana districts of West Bengal, Shillong in Meghalya and Dimapur in Nagaland). Samples were taken at a distance of 5-15 cm from around the base of the pseudostem. About 50 g roots with brown to black coloured spindle shaped lesions were collected at 5 to 25 cm depth. From each of the root samples, 10 g were randomly selected and cut into 2 cm long pieces. The root pieces were then cut longitudinally into four pieces and incubated over a period of 48 hrs. at 25°-27 °C. Nematodes were collected and examined under a stereoscopic binocular microscope. Population of individual genera collected from the roots, were examined and the interpretations were made according to the following parameters (Norton, 1978):

i) *absolute density* - specimens of different genera in each sample unit were counted and expressed as the population density of respective genera per 10 g root.

ii) *relative density*

$$\frac{\text{number of individuals in a genera/species in a sample}}{\text{total number of individuals in a sample}} \times 100$$

iii) *absolute frequency*

$$\frac{\text{number of samples containing a species}}{\text{number of samples collected}} \times 100$$

iv) *relative frequency*

$$\frac{\text{absolute frequency of species}}{\text{sum of frequency of all species}} \times 100$$

v) *prominance value*

$$\text{absolute density} \sqrt{\text{frequency}}$$

relates density and frequency of individual species in the pooled population of the 139 samples collected from all the regions.

Results and discussion

Radopholus similis is widely distributed in all the states, except Meghalaya, included in the study area. Highest frequency of occurrence was in Nagaland (100) followed by Uttar Pradesh (50), West Bengal (42.9), Bihar (21.8), Bihar (21.8) and Assam (16.7). Another nematode of economic significance, *Pratylenchus coffeae* (Zimmermann 1898) Filipjev *et* Schuμrmans, Stekhoven, was found only in Assam, Bihar and West Bengal. Its highest frequency (50) was in Assam, followed by West Bengal (28.6) and Bihar (15.8). *Helicotylenchus multicinctus* (Cobb 1893) Golden, was widely distributed through-

out the regions sampled. The highest frequency was in Uttar Pradesh (50) followed by Assam (45.8), Bihar (40.6), Nagaland (33.3) and West Bengal (14.3). Apart from these major nematodes, other genera viz. *Meloidogyne* sp., *Rotylenchulus reniformis* Linford *et* Oliveira, *Hoplolaimus* sp. and other genera belonging to the dorylaimid group were also invariably found either in the rhizoplane or deeply embedded in the roots. However, the population densities of individual genera in the group were comparatively low. Absolute density, relative frequency, relative density and prominance values of *R. similis* were 2853, 16.1, 8.8 and 1397.6, respectively. The corresponding values for *P. coffeae* were 7289, 20.4, 22.4 and 4058.3, for *H. multicinctus* 5883, 26.5, 18.1 and 3720.7, and for other nematodes 16580, 36.9, 50.9 and 12407, respectively. Data presented in Table I indicate the prevalence of *R. similis* in Ranchi and Lohardaga districts in Chotanagpur plateau of southern Bihar and Bhagalpur, Darbhanga and

TABLE I - *Occurrence of* Radopholus similis *on different banana cultivars grown in various north eastern states of India.*

Region		Period		Cultivar	Clone	Population Range
State	District	Year	Month			
Assam	Guwhati	1997	December	Dwarf Cavendish	AAA	1-8
	Sonitpur	"	"	Bheemket	ABB	
				Amritsagar	AAA	7-230
				Chenikal	ABB	
Bihar (North)	Bhagalpur/ Kathiar	1996	September	Singpore	AAA	1-8
	Darbhanga	1993	November	Dwarf Cavendish	AAA	0-270
Chotanagpur Belt (South)	Lohardaga	1993	January	Chinia	ABB	0-8
		1994	September	Suker Chinia	–	10-34
	Ranchi	1993	January	Bhusawal Dwarf Cavendish	AAA	1-132
		1993	November	Dwarf Cavendish	AAA	0-640
		1995	August/ September	Chinia/Kothia	ABB/ABB	2-110
Nagaland	Dimapur	1997	December	Jahazi	AAA	10-393
Uttar Pradesh	Allahabad	1993	November	Dwarf Cavendish	AAA	0-5
West Bengal	Midnapur Murshidabad 24-Parganas	1996	September	Monthan	ABB	1-2

Katihar districts of the northern region of Bihar state. Some cultivars in Ranchi district viz. Bhusawal/Dwarf Cavendish; Chinia; Chinia/Kothia, harboured populations of *R. similis* ranging between 1 and 132; 0 and 640; and 2 and 110 per 10 g root during January 1993, November 1993 and August/September 1994, respectively. Root samples collected from Chinia and Suker Chinia cultivars grown in Lohardaga district during November 1993 and September 1994 yielded populations ranging between 0 and 8 and 10 and 34 per 10 g root, respectively. Samples collected from the northern districts of Bihar viz. Darbhanga and Bhagalpur/Kathiar during November 1993 and September 1996 yielded populations ranging between 0 and 270 and 1 and 8, respectively. Populations were very low in root samples collected from the three districts in West Bengal (1-2 female/10 g root) and one district in Uttar Pradesh (0-5 females/10 g root). Population densities were also low on cv. Dwarf Cavendish in the Guwahati district of Assam state. On the other hand the root populations ranged between 7-230/10 g root in Bheemkel, Amritsagar and Chenikal cultivars grown in the Sonitpur district of Assam state. A relatively high range of root populations i.e. 10-393/10 g root of cv. Jahazi (Dwarf Cavendish) occurred in the Dimapur district of Nagaland state. Root samples collected from Muzaffarpur, Vaishali and Samastipur districts of Bihar state, Cachar districts of Assam and Shillong districts of Meghalaya state did not yield any life stage of *R. similis.*

The incidence of *R. similis* has been found to be widespread throughout the study area including the states like Assam, Bihar, Nagaland, Uttar Pradesh (eastern) and West Bengal. However, it was not detected in samples collected from Meghalaya state. The nematode is already known to be widely prevalent in States having more or less overlapping eco-denominations ranging from tropical to sub humid/humid tropics with annual rainfall from 40 to 100 cm in the major geographical areas of States like Tamil Nadu, Karnataka, Gujarat and parts of Andhra Pradesh, Madhya Pradesh, Maharashtra, between 100 and 200 cm in States like Orissa, Bihar, West Bengal, parts of Uttar Pradesh, Madhya Pradesh, Assam and Nagaland and between 200 and 400 cm in Tripura, parts of Assam, Manipur, Kerala, Karnataka and Maharashtra. Further, in majority of States in which *R. similis* occurs the ambient temperature does not drop below 15 °C and it may go up to 25 °C during January. Temperature regime ranges between >25 °C to 32.5 °C and >25 °C to <27.5 °C during July and October, respectively (Anon, 1990 a, b). A temperature regime of 24 °C to 32 °C has been found to be optimum for the completion of the life cycle of *R. similis* (Loos, 1962).

Following its detection in Kerala, *R. similis* was subsequently reported from the majority of States in which there is a significant area under banana cultivation. Except, for the golden nematode, there is no domestic quarantine in India against any other potential plant parasitic nematode (Mathur and Rana, 1995). The progressive spread of *R. similis* may be attributed to the free exchange of planting material amongst the researchers. Also, progressive farmers appear to have played a vital role in the exchange/transfer of planting material especially in the border regions of different states. In addition banana genetic material was distributed from the Indian Istitute of Horticultural Research, located at Chetahalli (Karnataka state; southern region of the country) to the centre located in southern region of Bihar, an eastern state (source-Central Horticultural Experiment Station, Ranchi banana germplasm accession register), lends credence to the contention that the research organisation was involved in the spread of the burrowing nematode to far flung areas (no. 3 to 11 as indicated in fig. 1). Occurrence and spread of the nematode in the northern region of Bihar may be ascribed to the introduction/acquisition of genetic planting material (no. 4 to 15 as indicated in fig. 1) both by the research station of the State Agricultural University located at Vaishali

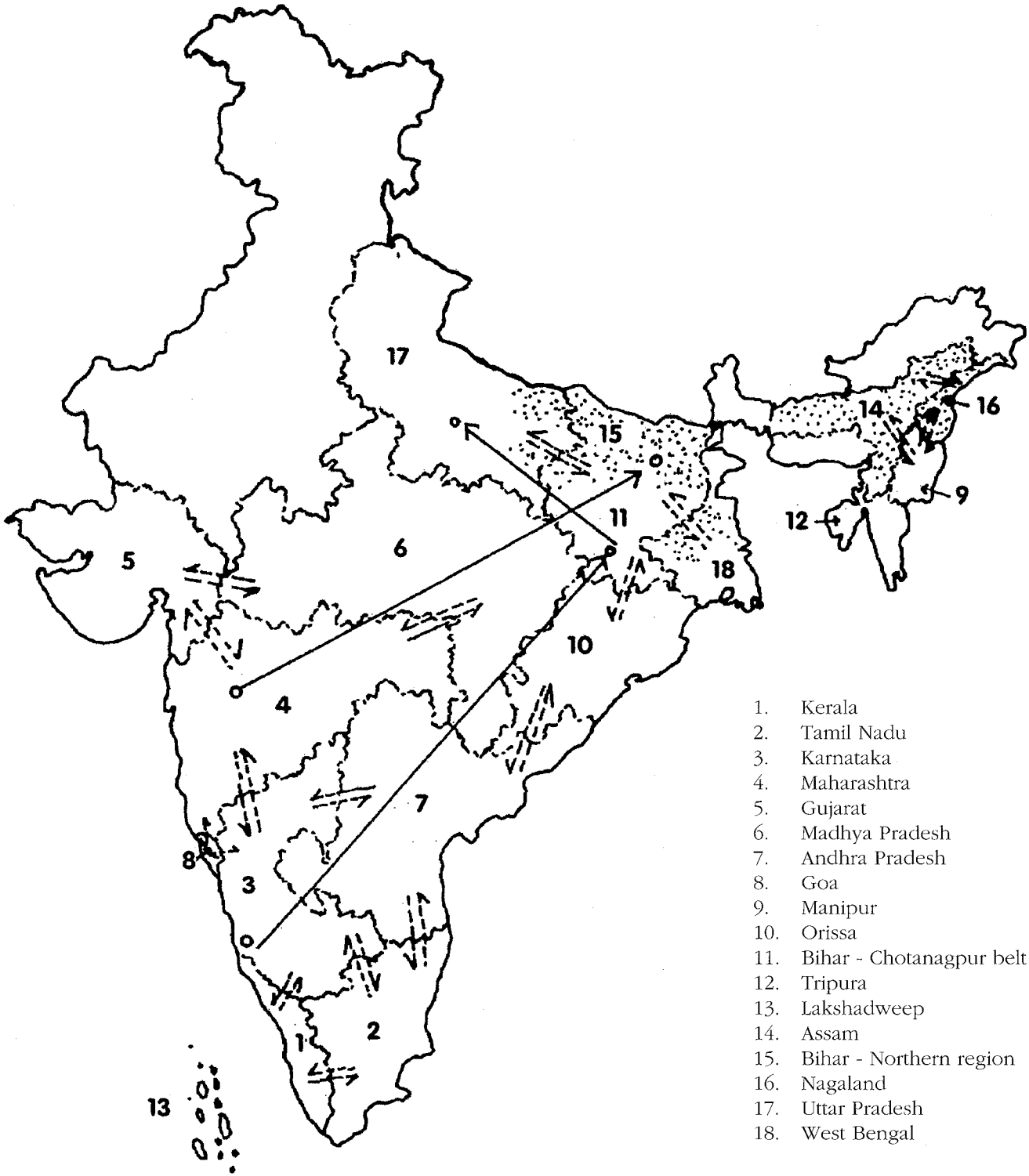

Fig. 1 - Distribution of *Radopholus similis* in India and possible routes of distribution (1 to 13 previous records; 14 to 18 new records; broken arrows indicate neighbouring states exchange of planting material, bold arrows transfer of germplasm from research organizations).

district of north Bihar (source-Fruit Research Station, Hajipur, Vaishali district accession register) and by the progressive farmers of the region especially from the Kathihar and Bhagalpur districts; nematode infestation has been detected in both districts. Transfer of banana germplasm from the Central Horticultural Experiment Station, Ranchi to an institute located in the Lucknow district of Uttar Pradesh (no. 11 to 17 as indicated in fig. 1) (personal communication with concerned scientists), with its subsequent distribution to farmers and close proximity of infected areas of the north-west region of Bihar to eastern region of Uttar Pradesh on one side and north eastern region of West Bengal, could be responsible for the spread of the nematode in Uttar Pradesh and West Bengal. Similarly the proximity of Manipur (no. 9) to Assam (no. 14) and Nagaland (no. 16) and Tripura (no. 12) to Assam could be the factor solely responsible for the introduction and spread of the nematode to new locations (fig. 1 indicates the possible ways/routes contributing to the spread of *R. similis*).

The burrowing nematode has been encountered throughout the year. The population density, however, was found to vary to a great extent. Low population densities were encountered in the cultivars Chinia (0-8), Singapore (1-8), Monthan (1-2), Dwarf Cavendish (0-5) and Dwarf Cavendish (1-8) collected from Lohardaga; Bhagalpur/Kathihar districts of Bihar; Midnapur, Murshidabad, 24-Pargana district of West Bengal; Allahabad district of U.P. and Guwhati district of Assam States, respectively. The low root population of *R. similis* in these cultivars in certain districts could be attributed to the high moisture level. In fact they were generally black and quite often in decaying stage.

Besides *R. similis*, other nematodes viz. *P. coffeae*, *H. multicinctus*, *Meloidogyne* sp., *R. reniformis* and *Hoplolaimus* sp. were also invariably found associated with the root system. By and large *P. coffeae* and *H. multicinctus* have been rated as pests of global significance (Gowen and Quénéhervé, 1990). Elsewhere in India. *P. coffeae*, *H. multicinctus*, *R. reniformis*, *Hoplolaimus* sp. and *Tylenchorhynchus* sp. have been found (Rajagopalan and Chinnarajan, 1976).

The cultivars harboured the varying degree of population of *R. similis* were found to belong to a varied group of clones viz. A.A.A. (cv. Amrit sagar., cv. Jahazi and cv. Bhusawal/Dwarf Cavendish from Assam and Nagaland and Bihar/Uttar Pradesh, respectively); A.B.B. (cv. Bheemkel; Chinia, Kothia; Monthan from Assam; Bihar and West Bengal, respectively). The nematode has been found to infect a variety of cultivars grouped under AAA and AAB and ABB clones from Africa (Gowen and Quénéhervé, 1990). The cultivars Virupakshi (AAB); Lactan (AAA) and Nalbotha (AAB) have been rated as highly susceptible, susceptible and susceptible, repectively (Reddy *et al.*, 1988).

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