Current Status of Entomopathogenic Nematodes Occurring in India along with New Record of *Steinernema feltiae* (Filipjev) Wouts *et al.* from Kerala

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Entomopathogenic nematodes belonging to the families Steinernematidae and Heterorhabditidae, are known to have high biocontrol potential against several insect pests of crops as well as some household pests (Gaugler & Kaya, 1990; Gaugler, 2002). Till now, about 55 species of *Steinernema*, one species of *Neosteinernema* and 11 species of *Heterorhabditis* have been described from all over the world, of which only two species viz., *S. thermophilum* Ganguly & Singh, 2000 and *H. indica* Poinar *et al.*, 1992 have been described from India. In India, research on entomopathogenic nematodes (EPN) is being carried out at different centers which has led to the isolation of several EPN strains, and only a few have been identified while several strains are yet in queue waiting for identification (Ganguly, 2003).

Table 1. Entomopathogenic nematode species described / reported from India.

Nematode species	Crop /soil	Locality / state	Reference
a) Described species			
Steinernema thermophilum	Greengram	IARI farm, New Delhi	Ganguly & Singh,2000
Heterorhabditis indica	Soil	Coimbatore, Tamil Nadu	Poinar *et al.*, 1992
b) Reported species			
S. bicornutum	Mango	IARI farm, New Delhi, Karnataka,	Hussaini *et al.*, 2001
S. carpocapsae	Tomato, okra, Banana, Cowpea, Field bean	Andhra Pradesh, Tamil Nadu	
	Soil	Meghalaya, Arunachal Pradesh	Ganguly & Rathour, 2004
S. feltiae	Maize	Bangalore, Karnataka	Hussaini *et al.*, 2001
	Soil	ICRISAT, Andhra Pradesh	Singh *et al.*, 1992
	Soil	CPCRI, Kerala	New Record
S. glaseri	Okra	Bangalore, Karnataka	Hussaini *et al.*, 2001
S. riobrave	Fieldbean	Kanpur, U.P.	Hussaini *et al.*, 2001
	Soil	Anand, Gujarat	Ganguly *et al.*, 2002
S. tami	Mustard	Jorhat, Assam	Hussaini *et al.*, 2001
S. siamkayai	Soil	Champawat, Uttaranchal	Ganguly *et al.*, 2005
Heterorhabditis bacteriophora	Citrus	Coonoor, Tamil Nadu	Hussaini *et al.*, 2001
	Soil	Assam & Meghalaya	Ganguly & Rathour, 2004
H. indica	Sugarcane, sapota, rose	Karnataka & Tamil Nadu	Hussaini *et al.*, 2001
		Manipur & Meghalaya	Ganguly & Rathour, 2004
	Maize	Bangalore, Karnataka	Hussaini *et al.*, 2001
	Soil	Kerala	Banu *et al.*, 1998

Current status of EPN species described / recorded from different states of India, is summarized in Table 1. *Steinernema abbasi* Elawad *et. al.*,1997, recorded from green gram fields of IARI farm by Hussaini *et al.*, 2001, was re-examined and identified as *S. thermophilum* because its males possessed an additional pair of cloacal papillae which are absent in *S. abbasi*. Two species *S. masoodi* and *S. seemae* described from pigeonpea fields in Kanpur, by Ali *et al.* (2005), were not included in the list because the species were poorly described with some serious errors in their descriptions and illustrations, lacking adequate morphological details, and also inappropriate 'diagnosis and relationships', wherein authors discussed the relationships with 'conveniently selected' species rather than 'closely related' species.

Present investigation also reports the occurrence of *S. feltiae* (Filipjev,1934) Wouts *et al.*, 1982, in Kerala, which is a new record of the species from this state in India. Earlier, Singh *et al.* (1992) reported the occurrence of *S. feltiae* in Andhra Pradesh. Soil samples collected from the rhizosphere of coconut (*Cocos nucifera*) in the farm area of CPCRI, Kayangulam, Idukki district, Kerala, were baited with last instar larvae of greater wax moth (*Galleria mellonella)* for isolating the entomopathogenic nematodes (Kaya & Stock, 1997). Among the extracted populations, one was assigned to the genus *Steinernema,* and designated as strain IARI-EPN-*Kl.* This strain was found to have very high insect biocontrol potential, since it could induce insect mortality within 24-48 h and emerged *en masse* within 4 to 5 days after the inoculation at 25-30°C. Detailed morphological and morphometrical studies of its different life stages (infective juveniles, males and females of two generations) revealed it to be closely resembling with *S. feltiae* in most of the characters. Morphometric features of infective juveniles of this strain, and those of type specimens of *S. feltiae* (Filipjev,1934) Wouts *et al.*, 1982, are presented in Table 2. The IJs of this strain showed close similarity with *S. feltiae* with respect to head shape, body length, position of excretory pore, oesophageal length, tail length, ratio a, ratio c and E %, but exhibited minor differences from the type measurements by having higher body width (28-34 vs. 22-29 µm); anal body width (19-23 vs. 15-17 µm); less a ratio (25-29 vs. 29-33 µm) and higher D % (52.4-56 vs. 42-51), which were however considered as intra-specific variations of *S. feltiae*. The strain IARI-EPN-*Kl* was thus identified as *S. feltiae,* which is a new record of this species from Kerala state in India.

Table 2. Comparative measurements of infective juveniles of strain IARI-EPN-*Kl* from Kerala state, India and type specimens of *Steinernema feltiae*.

Characters	Strain IARI-EPN-*Kl* (N=20)	Type Specimens of *S. feltiae*
Maximum Body Length (µm)	700-950	736-950
Maximum Body Width (µm)	28-34	22-29
Head to Excretory Pore (µm)	55-67	53-67
Head to Oesophageal base (µm)	112-155	115-150
Tail Length (µm)	72-90	70-92
Anal body width (µm)	19-23	15-17
Ratio a	25-29	29-33
Ratio c	9.9-13.0	9.2-12.6
D%	52.4-56.0	42-51
E%	73.0-88.8	69-86
F%	36.0-45.2	-

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Virulence of *Heterorhabditis indica* to the Grubs of Lucerne Weevil, *Hypera postica* (Coleoptera: Curculionidae)

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Lucerne (*Medicago sativa*), an important forage crop being cultivated both annually and as a perennial crop covering approximately one million hectare area in India is being seriously attacked by the grubs of *Hypera postica* causing a reduction of about 20-30 per cent green forage yield (Saxena *et al.* 2002). The entomopathogenic nematodes (EPN) had been evaluated against soil pests like white grubs and cut worms (Reed & Carne, 1967, Capinera *et al.* 1988). The present work is an outcome of a laboratory bio-assay utilizing *Heterorhabditis indica* against the grubs of *Hypera postica.*

Laboratory bio-assay test was conducted at Indian Grassland and Fodder Research Institute during 2005. Bio-assay tests were carried out utilizing well plates for inoculation purpose. In each treatment three third instar grubs of *Hypera postica* were placed in the well-plates. Dosage levels in the range of 10-160 infective juveniles(IJs) per well were used in five replications. Observations were recorded at intervals of 24 h.

There was a positive correlation between nematode concentration and *Hypera postica* mortality (Table 1). At 24 h after inoculation, there was 93.20% mortality of grubs of *H. postica* at a dose of 160 IJs, 86.4% mortality at 160 IJs, while 59.6, 33.0 and 6.60% mortality at 40, 20 and 10 IJs respectively. After 48 h of inoculation, there was 100, 93.2, 66.4, 46.2 and 13.2% mortality. At 72 h after inoculation, there was 100% mortality at a dose of 80 IJs while 79.6, 73.0 and 19.8% mortality at a concentration of 40, 20 and 10 IJs (Table 1). Thus, the mortality of *H. postica* increased with increase in exposure time. However, increase in *H. indica* concentration reduced the time for *H. postica* mortality. It was in conformity with the findings of Singh (1993) who also reported the increase in mortality of insect larvae with increase in time.

Table 1. Pathogenicity of *Heterorhabditis indica* against the grubs of *Hypera postica*

H.indica concentration	Per cent mortality of *Hypera postica*, after		
	24 h	48 h	72 h
10 IJs	6.6(11.40)*	13.2(17.36)	19.8(21.26)
20 IJs	33.0(33.18)	46.2(43.05)	73.0(48.23)
40 IJs	59.6(53.64)	66.4(60.32)	79.6(68.13)
80 IJs	86.4(74.81)	93.2(81.50)	100.0(88.19)
160 IJs	93.2(81.50)	100.0(88.19)	100.0(88.19)
CD at 5%	Concentration		-5.719
	Time		-4.430

* Figure in parenthesis are arc sin values.