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Rakesh Pashi

Department of Agricultural
Entomology, Bidhan Chandra
Krishi Viswavidyalaya,
Mohanpur, Nadia, West Bengal,
India

Ashim Maity

Department of Agricultural
Entomology, Bidhan Chandra
Krishi Viswavidyalaya,
Mohanpur, Nadia, West Bengal,
India

Matiyar Rahaman Khan

Division of Nematology, ICAR-
Indian Agricultural Research
Institute, New Delhi, India

Sandip Mondal

Indian Statistical Institute,
Giridih, Jharkhand, India

Abhishek Mukherjee

Indian Statistical Institute,
Giridih, Jharkhand, India

Correspondence

Matiyar Rahaman Khan
Division of Nematology, ICAR-
Indian Agricultural Research
Institute, New Delhi, India

Incidence of white tip nematode (*Aphelenchoides besseyi*) in rice in West Bengal

Rakesh Pashi, Ashim Maity, Matiyar Rahaman Khan, Sandip Mondal and Abhishek Mukherjee

Abstract

Surveys were conducted to document infestation of rice white tip nematode (*Aphelenchoides besseyi*) during the *boro* and *kharif* seasons in West Bengal. Results indicated that infection of *A. besseyi* in rice occurs in both the rice growing seasons. Among the districts surveyed, East (229-2054/100grains) and West Midnapore (69-2277/100grains) and South 24-Paraganas (249-1543/100 grains) were severely affected; the samples from these three districts showed *A. besseyi* infection of 37.57%, 55.17%, and 28.14%, respectively. Samples procured from Bankura also showed 30% infection of *A. besseyi*. The sample with low population (per 100 grains) recorded in Hooghly (81-111; 18%), Malda (71-78; 10%), Nadia (77-131; 6%), North 24-Paraganas (76-97; 18%), Purulia (80-101; 15%) and South Dinajpur (59-80; 45%) districts. However, 45% infection was recorded from samples collected from South Dinajpur district. Infestations ranged between 6 to 18% in other districts of West Bengal. No infestation was recorded from Cooch Behar district. The survey results confirmed that *A. besseyi* is one of the most important pests of rice in West Bengal in both *boro* and *kharif* seasons. Further, the areas infested with this nematode species are potential sources of nematode dissemination to other parts of India through production of nematode infected seed.

Keywords: Infestation, *Aphelenchoides besseyi*, *boro*, *kharif*, rice, West Bengal

1. Introduction

West Bengal is the largest rice producing state of India; it produces 15.3 million tonnes during 2013-14 ^[1]. Among the important phytoparasitic nematode infecting rice, white tip nematode (*Aphelenchoides besseyi* Christie, 1942), a seed-borne nematode is widespread among the rice growing parts of the world ^[2]. Infested rice plants show typical white tip symptom (whitening of top leaf) during vegetative growth stage of rice and distortion of upper parts of plants including flag leaf and panicles towards crop maturity. In India, the white tip disease symptom on rice was first time reported by Dastur ^[3] from central province, now in Madhya Pradesh. The occurrence of white tip nematode on rice with a threat on production of quality seeds has been reported from West Bengal ^[4]. The economic significance of white tip nematode in rice has widely been accepted and considered as a potential yield reducer; 10 to 30% yield losses in China ^[5], 40 to 50% in United States of America ^[6]; 20 to 60% in India ^[7]. The problem of white tip nematode in rice coincides with high rainfall, relative humidity and high temperature and almost similar conditions those are available during *kharif* (wet) season when *kharif* rice is cultivated. However, the infestation of *A. besseyi* in *boro* rice (summer rice) has recently been noticed under West Bengal conditions. Therefore, the present study was focused on conducting survey on *boro* as well as *kharif* rice to understand the incidence of *A. besseyi* on rice in West Bengal.

2. Materials and Methods

2.1 Survey and sample collection

Nematode specific survey was conducted during *boro* (January- May) and *kharif* (July-November) seasons in West Bengal. The climate of this state belongs to sub-tropical zone with high rainfall (1200-1700mm), south-west monsoon contributes maximum (80%) rainfall during July to September and temperature ranges between 15 to 35 °C. Infested panicles were collected randomly from farmer fields at different locations in rice growing districts across West Bengal., Surveys were conducted in 47 blocks, selected based on rice production data, in different districts.

In each block, 3-6 samples were collected with 4-6km between sample distances. Initially, three districts of West Bengal were surveyed during *boro* rice season and 8 districts during *kharif* rice season of 2015. The districts covered in this survey were West Midnapore, East Midnapore, South 24-Parganas, Bankura, Cooch Behar, Hooghly, Malda, Nadia, North 24-Parganas, Purulia, and South Dinajpur of West Bengal. In all, 765 rice plant samples were collected from different rice growing districts of West Bengal.

2.2 Nematode extraction

From each sample, 100 rice grains separated and pounded with a motor and pestle. They were soaked on a single tissue paper fitted over aluminium wire-gauge and placed over a Petri dish filled with clear tap water. The level of water in the Petri dish adjusted so that the bottom of the wire-gauge tissue paper assembly touches to soak the broken grains. The nematode emerged from the grains wriggled down and settled to the water below in the Petri Plate. A Petri dish was used to cover on the top of the assembly to prevent evaporation loss of water and drying up quickly. Most of the nematode came out from infected grain by 15-20 hours at room temperature of 25-35 °C. The nematode population estimated in the water suspension with the help of a multi-chambered counting disc under stereoscopic binocular microscope (OLYMPUS STEMI 2000 °C) and the population density of *A. besseyi* was expressed per 100 rice grains.

2.3 Identification of nematode species

Nematodes recovered from rice were killed in hot-water bath (65°C for 5 min.), fixed in 3% formaldehyde and processed by Seinhorst's glycerol-ethanol method [8]. All the processed nematode specimens (both male and female) were mounted on anhydrous glycerol on glass slide and sealed by wax-sealing method [9]. The species of *Aphelenchoides* was identified based on morphology and morphometrics of key taxonomic parameters [10].

3. Results and Discussion

The survey conducted on infestation of white tip nematode in West Bengal during *boro* and *kharif* seasons on rice based on collection of samples with distorted rice panicles from different districts of West Bengal. The symptoms produced by the white tip nematode are often confused with other kinds of abnormalities – discoloration of grains, chaffiness upon attack of insect, sterility of grains etc. The nematode develops characteristic symptoms; whitening and yellowing leaf tips about 3-5 cm of the leaf at vegetative stage, and distortion of the flag leaf, leaf sheath, sterility or distortion of individual grains in the affected panicles, distorted glumes and kernel, chaffy grains and shorter flag leaf [11]. The present survey was carried out towards harvesting of rice and, therefore, the early symptoms were not encountered. However, the distortion of glumes and panicles bearing chaffy grains (Figure 1) were confirmed based on laboratory analysis of symptoms and identification of nematode species. The white tip disease inducing nematode, *A. besseyi* was found in almost all the samples (Table 1) procured from different districts of West Bengal. The estimation of nematode population per 100 grains depicted severity of *A. besseyi* infestation; 53% samples represented with a low level of population (<500

nematodes/100 grains), 19% with moderate population (500-1000 nematodes/100 grains) and 26% samples with very high population density (>1000 nematodes/100 grains).

Among the districts surveyed, East (229-2054/100grains) and West Midnapore (69-2277/100 grains) and South 24-Parganas (249-1543/100 grains) were highly affected; 37.57%, 55.17%, and 28.14%, respectively sample were found to be infected with *A. besseyi* (Table 2). Samples collected from Bankura also showed infection (30%, n = 20) of *A. besseyi*. Among the districts of north Bengal, samples from Cooch Behar (n = 20) were found free from infection of *A. besseyi*. The sample procured from the districts showed relatively low level of population per 100 grains were Hooghly (81-111; 18%), Malda (71-78; 10%), Nadia (77-131; 6%), North 24-Paraganas (76-97; 18%), Purulia (80-101; 15%) and South Dinajpur (59-80; 45%). However, in samples (20) of South Dinajpur showed 45% infection with infection ranging between 6 to 18%. The distribution and density of *A. besseyi* in West Bengal is depicted in Figure 2.

The survey result confirmed that *A. besseyi* is one of the most important pests of rice especially for reduction of grain yield and quarantine significance. Earlier Dastur [3] reported its occurrence for the first time in rice from the former Central Provinces, now Chhattisgarh region of Madhya Pradesh (MP), and later the nematode has been documented from different states in India [11], particularly in the rice growing areas of Uttar Pradesh, MP, Tamil Nadu [13,14], Gujarat, Andhra Pradesh [15] and Tripura [16]. A serious outbreak of white tip disease was observed in 60% of the rice cultivars with the most seriously affected cultivars was HR12 and Pankaj in Andhra Pradesh [17]. The white tip disease of rice was reported as severe problems in the southern and eastern states of India; the yield losses estimated to be 20-30% due to the infestation of this nematode species [17]. The nematode species has also been reported from Nadia district of West Bengal on tuberose and has been proved as a causal agent of 'floral malady' [19, 20]. *A. besseyi* is now a well recognized pest of rice and tuberose in West Bengal [20] and in Odisha [21, 22]. The species has also been reported to cause a serious foliar disease of tuberose in the Mekong Delta of Vietnam; the same species infects on rice [2, 23]. The occurrence of white tip nematode infecting rice was reported from West Bengal; this was found only in *kharif* rice from many districts [24]. In fact, development of white tip symptom and deformation of rice grain is dependent on population density of nematodes in rice plant and other many abiotic factors [11]. In this investigation, differences in population densities were noted in the varying level among the rice samples. The white-tip nematode in rice is widely distributed as because of dissemination of infected seeds between localities, regions, and countries. The incidence and severity of the disease varies from year to year due to environmental factor, cultural practices and local rice types [25]. The present study further confirmed incidence and widespread occurrence of *A. besseyi* in both *boro* and *kharif* rice cultivars under West Bengal conditions. These results could be useful for the growers and extension specialists for their awareness on the deformities of rice panicles and grains due to the infection of *A. besseyi*; this nematode easily disseminate through infected seed, therefore, adequate cautions are required while collecting harvested produce for seed purpose.

Table 1: Occurrence of white tip nematode, *Aphelenchoides besseyi* in rice in West Bengal

Districts	Blocks (GPS)	No. of sample	No. of sample infested	Nematode population per 100 seed, Mean \pm SE	Percent of sample infested
East Midnapore	Bhagwanpur-I (N22.06392 E87.77488)	45	18	438.00 \pm 48.31	40.00
	Bhagwanpur-II (N22.08115 E87.67696)	14	6	846.5.00 \pm 28.42	42.85
	Contai-I (N21.77460 E87.75635)	11	6	2054.00 \pm 30.44	54.54
	Contai -II (N21.84142 E87.78182)	26	16	605.00 \pm 10.15	61.53
	Egra -II (N21.822060 E87.51878)	8	5	229.00 \pm 60.22	62.50
	Nandakumar (N22.13051 E87.86411)	22	3	262.00 \pm 43.02	13.63
	Potashpur-I (N22.05012 E 87.59052)	3	1	-	33.33
	Potashpur -II (N21.96323 E87.58176)	6	1	-	16.67
	Ramnagar-I (N21.68378 E87.62649)	15	6	652.00 \pm 96.24	40.00
	Ramnagar-II (N21.70317 E87.64816)	16	5	1144.00 \pm 58.87	31.25
	Tamluk (N22.24022 E87.92464)	7	0	-	-
West Midnapore	Debra (N22.36994 E87.56141)	33	16	1317 \pm 21.64	48.48
	Daspur (N22.60628 E87.72343)	3	1	-	33.33
	Ghatal (N22.66863 E87.71933)	10	5	1199.00 \pm 27.74	50.00
	Keshpur (N22.55326 E87.46869)	6	4	698.00 \pm 38.39	66.66
	Medinipore (N22.45531 E87.13066)	3	3	2277.00 \pm 94.00	100.00
	Pingla (N22.37400 E87.69989)	30	17	1496 \pm 31.34	56.66
	Sabang (N22.17460 E87.60070)	2	2	228.00 \pm 43.00	100.00
South 24 Parganas	Bishnupur (N22.35557 E88.26456)	13	10	1543.00 \pm 29.30	76.92
	Diamond Harbour-I (N22.20219 E88.234157)	15	7	323.00 \pm 82.47	46.66
	Diamond Harbour-II (N22.27068 E88.21165)	26	2	144.50 \pm 32.50	07.69
	Harindanga (N22.29235 E88.21414)	14	6	809.00 \pm 28.81	42.85
	Kulpi (N22.07645 E88.26485)	10	1	-	10.00
	Magrahat -I (N22.22055 E88.22231)	36	10	273.50 \pm 11.85	27.77
	Magrahat -II (N22.24835 E88.36987)	21	2	249.50 \pm 12.45	9.52
Bankura	Bankura-I (N23.359789 E86.939524)	10	4	69.50 \pm 10.63	40.00
	Chatna (N23.299438 E86.964265)	10	2	85.50 \pm 32.50	20.00
Cooch Behar	Tufanganj (N26.33001 E89.67085)	20	0	-	-
Hooghly	Chandipur (N21.452969 E87.015957)	20	3	98.00 \pm 21.42	15.00
	Haripal (N22.807002 E88.106114)	20	2	111.00 \pm 15.50	10.00
	Jangipara (N22.727028 E88.067576)	20	6	81.00 \pm 9.16	30.00
Malda	Old Malda (N25.054054 E88.145145)	20	0	-	-
	Habibpur (N25.008248 E88.290003)	20	0	-	-
	Chanchal-I	20	3	78.33 \pm 15.50	15.00

	(N25.382688 E88.021656)				
	Chanchal-II (N25.429420 E87.953099)	20	5	70.80 ±21.94	25.00
Nadia	Chakdah (N23.051589 E88.516862)	20	3	77.00 ±6.08	15.00
	Haringhata (N22.931362 E88.530976)	20	2	130.50 ±46.50	10.00
	Ranaghat-I (N23.179896 E88.547734)	20	0	-	-
	Ranaghat-II (N23.203998 E88.618051)	20	0	-	-
North 24 parganas	Barasat-I (N22.715568 E88.460895)	20	2	76.00 ±17	10.00
	Deganga (N22.700960 E88.653692)	20	5	97.40 ±13.48	25.00
	Habra-I (N22.839813 E88.636848)	20	4	81.75 ±22.61	20.00
Purulia	Arsha (N23.326454 E86.186746)	10	5	101.00 ±13.45	50.00
	Bagmundi (N23.193249 E86.037573)	10	4	86.25 ±21.59	40.00
	Purulia-I (N23.354332 E86.377226)	10	0	-	-
South Dinajpur	Gangarampur (N25.413819 E88.529903)	10	5	80.00 ±7.85	50.00
	Kumarganj (N25.421610 E88.719889)	10	2	59.00 ±17.00	20.00

Table 2: Presence of white tip nematode (*Aphelenchoides besseyi*) in rice seed sample from rice field in West Bengal

Districts	Nematode population per 100 grains (Range)	Percentage of sample infested
East Midnapore	229-2054	37.57
West Midnapore	698-2277	55.17
South 24-Parganas	249-1543	28.14
Bankura	86	30.00
Cooch Behar	*	*
Hooghly	81-111	18.33
Malda	71-78	10.00
Nadia	77-131	6.25
North 24 Parganas	76-97	18.33
Purulia	80-101	15.00
South Dinajpur	59-80	45.00

*- not detected



Fig 1: Distortion of glumes and panicles bearing chaffy grains encountered during survey

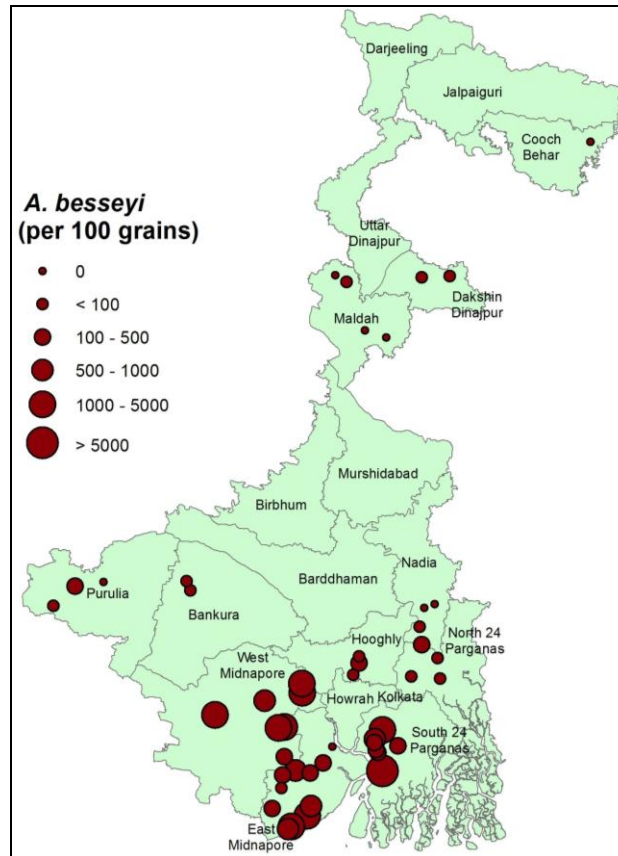


Fig 2: Distribution and density of *Aphelenchoides besseyi* infecting rice in West Bengal

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