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

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Abstract
A field experiment was conducted to test the efficacy of treatments for the control of white tip nematode (*Aphelenchoides besseyi*) in rice during 2015. Results showed that administration of treatments in rice cultivation significantly reduced white tip disease symptoms and nematode population in rice grain. The seed treatment with monocrotophos 36 SL @ 0.075% before sowing was found to the most effective for reduction of foliar distortion and increase of yield for the control of nematode. The foliar spray of monocrotophos 36 SL @ 0.075% at 20 DAS (days after sowing) and 50 DAS at boot leaf stage reduced nematode infestation. The seed treatment with carbosulfan 25 EC @ 0.075%, and hot-water at 52-53˚C water for 10 minutes effectively controlled nematode and enhanced rice yield. The present study demonstrated that all the treatments are effective to control the nematode and the rice grower can adopt any treatments depending upon suitability and resources conditions.

Keywords: Management, hot-water treatment, chemical nematicides, *Aphelenchoides besseyi*, *kharif*, rice, West Bengal.

1. Introduction
Rice is one of the most important food crops of India. Among the other phytoparasitic nematodes infecting rice, the white tip nematode (*A. besseyi*) is a serious pest of rice [1]. In India, white tip disease of rice was first reported by Dastur [2] from central province (now in Madhya Pradesh-MP). The nematode is ecto-endoparasitic in nature. The infection of the nematode induces a characteristic symptom - whitening of the leaf tip that turns to necrosis, distortion of the flag leaf that encloses the panicle, stunted growth of infected plants, reduced vigour and panicles contain small and distorted grain [3]. Infestation of *A. besseyi* may cause yield losses up to 60% [4], in China 10 to 30% [5] and in India 20 to 60% [6]. The nematode is widespread in India, particularly in rice growing areas of Uttar Pradesh, MP, Jharkhand, Gujarat, West Bengal, Odisha, Andhra Pradesh, Kerala and Tamil Nadu [7-10]. In West Bengal, it is prevalent in most of the districts and infecting *boro* and *kharif* rice [11, 12]. In West Bengal, *A. besseyi* is infecting both rice and tuberose in rice-tuberose cropping system [13] and the first occurrence of 'floral malady' due to *A. besseyi* in tuberose reported from Ranaghat areas of Nadia district in West Bengal [14]. The incidence of white tip nematode has been reported from West Bengal, Jharkhand and Odisha for last few years and the possible source of the nematode dissemination through nematode infected rice seed has been identified. Several approaches of control for white tip nematode have been reported to be effective. The present investigation was carried out with an objective to test the efficacy of treatments for the control of white tip nematode, *A. besseyi* in rice.

2. Material and Methods
2.1 Location of the experimental site and growing season
The experiment was carried out during *kharif* season of 2015 in an established plot at Central Research Farm of Bidhan Chandra Krishi Viswavidyalaya (BCKV), Nadia, and West Bengal. The farm is located at 23ºN latitude and 89ºE longitudes at an elevation at 9.75 meter from the mean sea level. The soil of the experimental field was typically Gangetic New alluvial soil having sandy clay loam texture with good drainage facility. The rice was cultivated during *kharif* season during August 2015 to November 2015. The meteorological data during *kharif* season is given below to understand the weather conditions favouring nematode infection.

Table 1: Meteorological data during the entire crop growth period of 2015

Year	Month	Mean temp. (ºC)		Mean RH (%)		Rainfall (mm)
		Max.	Min.	Max.	Min.	
2015	Aug.	33.41	25.57	94.64	78.67	215.7
	Sep.	33.50	24.6	95.36	76.63	217.9
	Oct.	32.38	21.92	93.1	66.87	8.8
	Nov.	30.45	16.87	98.4	55.16	0.00

Source: All India Coordinated Research project on Agrometerology, BCKV, Kalyani Center, Nadia, West Bengal.

2.2 Details of experiment

The white tip nematode infested rice cv IET-4786 was procured from farmers' field. The seed lot was examined for the presence of white tip nematode (310 nematode/100 grains) before the use for experimental purpose. An experimental field was selected in the University farm. The experimental field was divided into 20 plots, each plot measuring 2m × 2m with a requisite buffer area 0.5m × 0.5m between the plots; the plots were laid out in Randomized Block Design. Five treatments were distributed in 20 plots so that each treatment comprised of four replications. The treatments of the study were: T1- Hot water treatment (52-53 ˚C water for 10 minutes), T2- Seed treatment with monocrotophos 36 SL @ 0.075%, T3- Seed treatment with carbosulfan 25 EC @ 0.075%, T4- Foliar treatment with monocrotophos 36 SL @ 0.075% at 20 DAS(days after sowing) and 50 DAS and T5- Untreated control. Seed treatments with monocrotophos 36 SL @ 0.075% and with carbosulfan 25 EC @ 0.075% were done almost 6 hours before the sowing of crop. The foliar treatment with monocrotophos 36 SL @ 0.075% was given at 20 DAS and 50 DAS. The white tip **s**ymptom due to the infection of *A. besseyi* and counting of distorted panicle were recorded at boot leaf stage of rice plant; 20 randomly selected plants from each plot. At the harvest of rice, 20 fully matured panicles 20 randomly selected plants from each plot, population of *A. besseyi* extracted in laboratory from the collected samples, final grain yields (kg/ha) and percentage increase over control plot was determined.

2.3 Nematode extraction, estimation and identification

Population of nematodes was extracted from collected rice panicles. From each sample, 100 rice grains separated and cut into small pieces and immersed in water of a Petri dish for 18-20 hours at room temperature of 20-35 ºC. After extraction of nematodes the glass beaker containing nematode suspension was plunged in hot-water that was kept on a hot-plate and shaken for uniform bathing of nematodes for 2-5 minutes at 60˚C. The killed nematode specimens were fixed in 3% formaldehyde and further processed by Seinhorst's glycerol-ethanol method [15]. Fixed nematode suspension was made to a volume of 100 ml for each sample; 5 ml of nematode suspension from each sample was transferred to a multi-chambered counting disc and observed under the stereoscopic microscope (OLYMPUS STEMI 2000C). For identification of nematode species, processed nematode specimens was transferred into a drop anhydrous glycerol on a glass slide and sealed by wax sealing method. The species of *Aphelenchoide*s was identified based on morphology and morphometrics of key taxonomic parameters [16].

2.4 Statistical Analysis

The experimental data was subjected to ANOVA and Duncan's Multiple Range Tests (DMRT) at 5 probability level of significance for interpretation of experimental results.

3. Result and Discussion

Results (Table 2) showed that the application of the seed treatment with monocrotophos 36 SL (T_2) before the time of sowing proved effective for the reduction of distortion of panicle and reduction (10.42-23.49%) of infestation at boot leaf stage. In the plots receiving foliar application of monocrotophos 36 SL (T_4) showed distortion of panicle to the extent of 20.98%, seed treatment with carbosulfan 25 EC (T_3) 20.93% and seed treatment (T_1) with hot-water 10.42%. All the treatment significantly reduced distortion of panicle in rice over untreated control.

Table 2: Effect of treatment on rice at boot leaf stage

Treatment	Percent of distorted panicle	Percent decrease of infestation over control
T1 : Hot water treatment at 52-53˚C water-for 10 minutes	19.25[b]	10.42
T2 : Seed treatment with monocrotophos 36 SL @0.075%	16.44[b]	23.49
T3 : Seed treatment with carbosulfan 25 EC @ 0.075%	16.99[b]	20.93
T4 : Foliar treatment with monocrotophos 36 SL @ 0.075%	16.88[ab]	20.98
T5 : Untreated control	21.49[a]	-
S. Em±	1.16	-
CD(*P*= 0.05)	3.43	-

Data marked by common letter are not statistically significant according to Duncan's Multiple Range Test at 5% level of probability

Table 3: Effect of treatment on yield attributes of rice.

Treatment	Yield (kg/plot)	Yield (kg/ha)	ICBR	Percent increase in yield over control
T1 : Hot water treatment at 52-53˚C water-for 10 minutes	0.84[a]	2100	2.43	34.4
T2 : Seed treatment with monocrotophos 36 SL @0.075%	0.99[a]	2481.25	2.87	58.8
T3 : Seed treatment with carbosulfan 25 EC @0.075%	0.96[a]	2400	2.78	53.6
T4 : Foliar treatment with monocrotophos 36 SL @0.075%	0.87[a]	2175	2.52	39.2
T5 : Untreated control	0.625[b]	1562.5		
S.Em±	0.04			
C.D(*P*= 0.05)	0.13			

Data marked by common letter are not statistically significant according to Duncan's Multiple Range Test at 5% level of probability.

Table 4: Population of *Aphelenchoides besseyi* population before harvesting of rice.

Treatment	Nematode population per 100 seed, Mean±SE	Percent decrease in population over control
T1: Hot water treatment at 52-53˚C water-for 10 minutes	254.73±12.50	17.93
T2: Seed treatment with monocrotophos 36 SL @0.075%	195.17±7.85	37.12
T3: Seed treatment with carbosulfan 25 EC @0.075%	205.25±10.63	33.87
T4: Foliar treatment with monocrotophos 36 SL @0.075%	218.29±9.93	29.67
T5: Untreated	354.87±21.24	-

Data marked by common letter are not statistically significant according to Duncan's Multiple Range Test at 5% level of probability.

In the present study, the highest yield (0.99kg/ plot) of rice was recorded in seed treatment with monocrotophos 36 SL @ 0.075% (0.99 kg/plot) followed by seed treatment with carbosulfan 25 EC @ 0.075% (0.96 kg/plot), foliar treatment with monocrotophos 36 SL @ 0.075% at 20 DAS (days after sowing) and 50 DAS (0.87 kg/plot) and hot-water treatment (0.84 kg/plot) (in Table 3). This was evident that the yield of rice was more in comparison to untreated control; the percent increase in yield over control was more in T2 (58.8%) followed by T_3 (53.6%), T_4 (39.2%) and T_1 (34.4%). Among the different treatments, seed treatment with monocrotophos 36 SL @ 0.075% (T_2) was found superior in terms of reducing white tip nematode population over the control; the reduction of nematode population in harvested grains over control was 37.12%. The next promising treatments were seed treatment with carbosulfan25 EC @ 0.075% (T3), foliar spray with monocrotophos 36 SL @ 0.075% at 20 DAS and 50 DAS (T4) and hot-water treatment (T1) for reduction of white tip nematode population 33.87%, 29.67%, and 17.93% respectively (Table 4). All the treatments involving costs and increase of grain yields, and, therefore, incremental Cost Benefit Ratio (ICBR) was found favourable. Results of this experiment clearly revealed from Table 2-4 that treatments T_1 to T_4 are superior to untreated control indicating adoption of any above-mentioned treatments could be effective against white tip nematode. However, there were significant differences among the treatments (T_1 to T_4) in respect of percent of distorted panicle, yield, nematode population per 100 seed and reduction of white tip nematode population. Considering relative performance of treatments administered in this study, the seed treatment with monocrotophos 36 SL @ 0.075% was found better for improving plant growth, yield attributes and reduction of *A. besseyi* population in comparison to T_1, T_3, and T4. The study of Nandakumar *et al*. [17] suggested to activate dormant state of *A. besseyi* by soaking contaminated rice seeds into water at 28 ºC for 12-15 hours followed by hot-water treatment for effective control at 52 ºC for 10 minutes. Prasad *et al*. [18] also reported efficacy of hot water treatment at 53-54 ºC of seeds pre-soaked for 6 hours; atmospheric fumigation (aluminium phosphide at 9.3 g/ m^3 for 72 h) of seeds pre-soaked in 0.2% mancozeb and monocrotophos solution for 6hours; and chemical spraying with 0.2% monocrotophos at 15 and 50 days after transplanting of rice cv. Phalguna. However, they obtained higher yield and greater number of filled grains with chemical spraying and atmospheric fumigation in comparison to hot water treatment. Cho *et al*. [19] suggested chemical control of *A. besseyi* in rice by adoptions of seed disinfection before seeding and soil application of carbofuran 3G before transplanting or seed disinfection plus carbofuran 3G water surface treatment at the early stage of injury. Further study by Prasad *et al*. [20] reported effective elimination of white-tip nematode by soaking seed in water followed by hot water treatment at 52 ºC for 30 minutes and vacuum fumigation. However, this practice resulted in complete loss of seed viability. The efficacy of monocrotophos 36 EC for the control of *A. besseyi* in rice by spraying at 1000 ml/ha during boot leaf stage [21] has been reported. Similar efficacy of monocrotophos 36SL at 500-700 ppm against *A. besseyi* in tuberose has also been demonstrated; the application of monocrotophos 36SL at 700ppm as bulb treatment for 6hours followed by four foliar sprays at 15 days interval significantly reduced floral malady in tuberose [22, 23]. The same nematode species causes white tip disease in rice and floral malady in tuberose. Among the seed-borne pathogens of rice, *A. besseyi* Christie, 1942 is considered to be a major problem; it is causing white tip disease which is widely distributed in almost all rice growing regions of the world, this result in low yield and poor seed quality [22]. This nematode is widely distributed in the rice fields of many states of India, including West Bengal, Andhra Pradesh, Madhya Pradesh and Gujarat [10]. During tillering stage, nematode feeds ectoparasitically on apical stem meristems [25], slowing migrates to the developing panicle, finally enters the spikelets before anthesis, and feed ectoparasitically on embryo, lodicules, ovary, and stamens [26]. In the mature rice grains, the nematode coil into a state of anabiosis and can survive up to 3 year in the stored grains [25]. The typical symptom of *A. besseyi* has been described by Yoshii and Yamamoto [25] and Todd and Atkins [27]. However, all those are often confused with the nutrient deficiency symptoms. Infestation of white tip nematode in rice yield losses to the extent of 70%, although varying with rice variety, year, and country [25, 28, 29, 30]. In India, there is a report on yield losses due to *A. besseyi* in rice ranging from 20 to 60% [6] but no systematic studies have been conducted to understand the extent of yield losses. The present study tested efficacy of chemical nematicides and hot-water treatment but the nematode could be effectively controlled by adoption of integrated approaches using cultural practices including nematode free seeds, resistant cultivars, and chemical nematicides. Along with this, the awareness campaign on prophylactic measures like hot-water or chemical treatments of seeds for elimination of nematodes from the infected seed grains might benefit to the growers. The approaches like chemical treatments of seeds, seedlings, and soil have been suggested for the control of white tip nematode in rice [31, 32].

The present study demonstrated that white tip nematodes could be managed with the adoption of seed treatment either with monocrotophos 36 SL or carbosulfan 25 EC at 0.075% and foliar spray with monocrotophos at 0.075% 20 DAS and 60 DAS. The seed treatment with hot-water at 52-53 ˚C water for 10 minutes have been suggested by several workers but its practical adoption and risks for the loss of seed viability at farmers level outweigh all benefits.

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5. References

1. Davide RG. Nematodes problems affecting agriculture in the Philippines. Journal of Nematology. 1988; 20(2):214-218.
2. Dastur JF. A nematode disease of rice in the central provinces. Proceedings of Indian Academy of Science. 1936; 4:108-122.
3. Ou SH. (ed.). Rice Diseases. Slough, UK, Commonwealth Agricultural Bureau, UK, 1985, 380.
4. Bridge J, Plowright RA, Peng D. Nematode parasites of rice, In: M. Luc, M., Sikora RA. and J. Bridge (Eds.). Plant parasitic nematodes in subtropical and tropical agriculture. CAB International, Wallingford, UK, 2005, 87-131.
5. Wang ZM, Zhou FM, Lu YL, Lu HF, Lu XL, Xu MB *et al*. The causes of small grains and erect ears of rice and its control countermeasures in Jiangsu province. Jiangsu Agricultural Science. 2003; 5:1-6.
6. Rao YS, Prassad JS, Panwar MS. Nematode pest of rice in India. Non insect pest and predator, 1985, 65-71.
7. Muniappan R, Seshadri AR. On the occurrence of white tip nematode of rice in Madras State. Madras Agricultural Journal. 1964; 51:510-511.
8. Sivakumar CV. White tip nematode in Kanyakumari district, Tamil Nadu. Indian Journal of Nematology. 1987; 17:72-75.
9. Khan MR**.** White tip nematode infestation in rice. In: M.R. Khan and M.S. Jairajpuri (Eds.). Nematode Infestation, Part-I: Food Crops, The National Academy of Sciences, India. 2010; 140-170:325.
10. Khan MR, Handoo ZA, Rao U, Rao SB, Prasad JS. Observation on the foliar nematode, *Aphelenchoides besseyi*, infecting tuberose and rice in India. Journal of Nematology. 2012; 44(4):391-398.
11. Das TK, Khan MR. Occurrence and distribution of white tip nematode, *Aphelenchoides besseyi* in West Bengal, India. Indian Journal of Nematology. 2007; 37(1):94-97.
12. Pashi R, Maity A, Khan MR, Mondal S, Mukherjee A. Incidence of white tip nematode (*Aphelenchoides besseyi*) in rice in West Bengal. Journal of Entomology and Zoology Studies. 2017; 5(2):200-208.
13. Khan MR. White tip nematode, *Aphelenchoides besseyi* in rice tuberose cropping system. In: S.K. Mukhopadhyay, D.C. Ghosh and G.C. De (Eds.). Proceedings of National seminar on frontiers of crop management. Visva-Bharati, Sriniketan, India. 2001, 142-144.
14. Chakraborti HS, Ghosh SC. Studies on the floral malady of *Polianthes tuberose* L. Journal of Mycopathological Research. 1993; 33:25-28.
15. Seinhorst JW. A rapid method for the transfer of nematodes from fixative to anhydrous glycerine. *Nematologica*. 1959; 8:67-69.
16. Hunt DJ. Aphelenchida, Longidoridae and Trichodoridae-their Systematics and Bionomics, CAB International, UK, 1993, 352.
17. Nandakumar C, Prasad JS, Rao YS, Rao J. Investigation on the white tip nematode (*Aphelenchoides besseyi* Christie 1942) of rice (*Oryza sativa* L.). Indian Journal of Nematology. 1975; 5(1):62-69.
18. Prasad JS, Rao LVS, Varaprasad KS. Management of white-tip nematode, *Aphelenchoides besseyi* in rice. Resources management in plant protection during twenty first century, Hyderabad, India, 14-15 2002; II:90-92.
19. Prasad JS, Varaprasad KS. Elimination of white tip nematode, *Aphelenchoides besseyi* from rice seed. Fundamental and Applied Nematology. 1992; 15(4):305-308.
20. Cho SS, Han MJ, Yang JS. Chemical control of rice white tip nematode (*Aphelenchoides besseyi*) by seed disinfectant and in the paddy field. Korean Journal of Plant Protection. 1987; 26(2):107-111.
21. Ramakrishnan S, Rajendran G. Management of rice nematodes through *Pseudomonas fluorescens*. *Proceedings of National Symposium on Biodiversity and Management of Nematodes in Cropping Systems for Sustainable Agriculture*, Jaipur, India. 2003, 144-147.
22. Pathak B, Khan MR. Comparative Field efficacy of chemical, botanical and biological agents against foliar nematode, *Aphelenchoides besseyi* infecting tuberose. Presented in National Seminar on Recent Advances and Research Priorities in Indian Nematology. at IARI, New Delhi, 2005.
23. Khan MR, Shit S, Pal AK, Biswas B. Integrated approach for management of foliar nematode, *Aphelenchoides besseyi* infecting tuberose in West Bengal, India. International Journal of Nematology. 2005; 15(1):30-34.
24. Rajan AL, Mathur VK. Host range and morphological studies on four isolates of *Aphelenchoides besseyi* Christie. Indian Journal of Nematology. 1990; 20:177-183.
25. Yoshii H, Yamamoto S. A rice nematode disease Senchu Shinagaro Byo. I. Symptom and pathogenic nematode. II. Hibernation. III. Infection course of disease. Journal of Agriculture. Kyushu University. 1950; 9:223-233, 287-292.
26. Huang CS, Huang SP. Binomics of white tip nematode, *Aphelenchoides besseyi* in rice florets and developing grains. Botanical Bulletin of Academy Sinica. 1972; 13:1-10.
27. Todd EH, Atkins JC. White tip disease of rice. 1. Symptoms, laboratory culture of nematodes, and pathogenicity tests. Phytopathology. 1958; 48:632-637.
28. Yamada W, Shiomi T. Studies on the rice white tip disease. II. Disease control with special reference to rice seed disinfection. Special Bulletin No. 47.1950; Okayama Prefecture Agricultural Experimental Station, Okayama, Japan.
29. Atkins JG, Todd EH. White tip disease of rice. III. Yield tests and varietal resistance. Phytopathology. 1959; 49:89-191.
30. Tamura I, Kegasawa K. Studies on the ecology of the rice nematode, *Aphelenchoides besseyi* Christie. V. On the abnormal growth of rice plant and decrease in yield caused by rice nematode. Japanese of Ecology. 1959; 9:120-124.
31. Fortuner R, Orton Williams KJ. Review of the literature on *Aphelenchoides besseyi* Christie, 1942, the nematode causing white tip disease in rice. Helminthological abstracts. Series B. Plant Nematology. 1975; 44:1-40.
32. Bridge J, Luc M, Plowright RA. Nematode parasites of rice, In: Luc, M., Sikora, R.A. and Bridge, J. (Eds.). Parasitic nematodes in subtropical and tropical agriculture. CAB International, Oxon, UK. 1990, 69-108.