FREQUENCY OF THE WHITE TIP NEMATODE, *APHELENCHOIDES BESSEYI*, IN GHANA AND ITS MANAGEMENT WITH BOTANICALS

K. Osei* and J. Sackey-Asante

Crops Research Institute, P. O. Box 3785, Kumasi, Ghana

Summary. Investigations were undertaken to ascertain the distribution of the white tip nematode of rice, *Aphelenchoides besseyi*, in Ghana and the potential of botanicals to control the nematodes in rice seeds. The plant products tested were neem (*Azadirachta indica*) seed, pepper (*Capsicum frutescens* cv. Legon 18) and wood ash, at 15 g/kg, in comparison with the nematicide, carbofuran, also at 15 g/kg, as seed dressing treatment. Some 80% of seed samples were infested in the Northern region, 72.5% in the Western, 67.5% in the Ashanti and 25% in the Volta regions. The population of *A. besseyi* in seeds was significantly ($P < 0.05$) reduced by ground pepper (83.5%), ground neem seeds (82.4%), wood ash (71.7%) and carbofuran (77.6%), with no significant differences between the treatments. However, the treatments reduced rice seed germination by 9.6-24.4% with pepper resulting in the greatest reduction (24.4%).

Key words: *Azadirachta indica, Capsicum frutescens,* carbofuran, control, *Oryza sativa,* wood ash.

Aphelenchoides besseyi Christie is the causal agent of the white tip disease of rice, *Oryza sativa* L. (Ou, 1985). Although the nematode has been found in rice fields in Ghana, the white-tip disease has not been reported yet in the country. Information on its frequency in different regions of Ghana would help to predict the likely severity of attack by this nematode and to implement appropriate management tactics.

The management of *A. besseyi* may exploit the use of resistant cultivars (Popova *et al.*, 1994), crop rotation (Kim *et al.*, 1996), and chemicals (Gregon and Prot, 1993). However, this nematode is seed-borne (Ou, 1985) and, therefore, seed treatment before sowing would also appear to be a sound control strategy. Hot water treatment of seeds (Borovkova, 1967) is both effective and economical, but failure to monitor temperature and duration of the treatment accurately could prove counter-productive (Bridge *et al.*, 2005).

The potential of botanicals in the management of nematodes is yet to be fully exploited. Moreover, the management of *A. besseyi* in rice has not been studied in Ghana. Therefore, the objectives of this study were to assess the frequency of *A. besseyi* in the country and to compare environmentally friendly options that may help to manage the white tip nematode and replace carbofuran, which has been banned in the country.

* Corresponding author: e-mail: k.osei@reading.ac.uk

MATERIALS AND METHODS

Assessment of the nematode frequency. Fifty samples of rice, i.e. 20 samples from the Northern and 10 samples each from the Western, Ashanti and Volta regions of Ghana, from a total of fifteen different cultivars of rice, were randomly collected from farmers barns during a survey. The cultivars (Table I) were four from the Northern region (TOX 3107, Mandii, Kukulubehi and Rock), two from the Western region (Agya Amoa and Red Rice), four from the Ashanti (Mr. More, 08, Mr. Harry and Mandii), and six from the Volta regions (Kawomo, Viono, WAB 209-5-HB, Damansah, Adaisi and IDSA 85). Cv. Mandii was sampled both in the Northern and Ashanti regions.

Four sub-samples from each of the 50 samples were assessed for the presence of the white tip nematode, *A. besseyi*. Randomly taken sub-samples of about 5 g each of the various cultivars were used for nematode extraction. The husks were peeled in a Petri dish and husks and caryopsis were left separately in water overnight (Huang and Huang, 1972). During this period, the suspension became milky due to fermentation and release of endosperm material. Therefore, after 24 h, the preparation was washed thoroughly on a standard sieve of 50 µm mesh to eliminate the milky materials. Nematodes were then extracted from the residue remaining on the sieve using a modified Baermann method (Rodriguez-Kabana and Pope, 1981). The set-up was left overnight before nematodes were collected in a beaker and counted under a stereoscopic microscope at × 50 magnification. Percentages of infested samples per region were then calculated.

Investigation on nematode management. The cv. Mandii, which was highly and uniformly infested, was selected for the studies on the control of the nematode in the infested seeds of rice. The tests were conducted in January 2003 and repeated in March of the same year at The Crops Research Institute, Kumasi. The aim was to compare the nematicidal efficacy of the plant products ground neem (*Azadirachta indica* A. Juss) seed, ground pepper (*Capsicum frutescens* L. cv. Legon 18) fruits and wood ash with that of the prescribed nematicide carbofuran (granules containing 95% a.i.).

Aliquots of 1 kg of rice grain stock were thoroughly mixed with 15 g of each product. The granules of carbofuran were ground into powder to ensure better contact with the rice seed. The seeds were thoroughly mixed with the various materials and kept in special woven khaki bags. Control seeds received no treatment. The experiment was arranged according to a randomised complete block design and each treatment was replicated three times.

After three months, 100 seeds were randomly picked from each replicate and nematodes extracted as described earlier. In addition, twenty-five seeds from each replicated treatment were randomly selected and plated on moistened tissue paper in a Petri-dish. The treatments were monitored for germination over a seven-day period.

Data were subjected to a one-way analysis of variance (ANOVA) using the Genstat 8 statistical package to test differences amongst treatments. Data on nematode counts were log transformed [ln (x + 1)] before analysis to comply with the assumption of normal distribution.

RESULTS

Assessment of the nematode frequency. Among the different regions surveyed, the most heavily infested seed came from the Northern (80%), followed by the Western (72.5%), Ashanti (67.5%) and Volta (25%). The cv. Mandii (10 samples from the Northern region and 3 samples from the Ashanti region) was 100% infested with *A. besseyi* (Table I). All cultivars were found infested to some extent in the Northern, Western and Ashanti regions. In the Volta region, however, the cultivars IDSA 85 and Viono were not infested by the nematode (Table I).

Investigation on nematode management. All of the treatments suppressed significantly the numbers of *A. besseyi* in rice grains ($P < 0.05$) and there was no difference ($P < 0.05$) between the three plant products and carbofuran (Table II). The average reductions of *A. besseyi* population of both tests were 83.5% by pepper, 82.4% by neem seeds, 77.6% by carbofuran and 71.7%

Table I. Incidence of *Aphelenchoides besseyi* in stored rice seeds.

Region	Cultivar	Samples	Intensity of infection[1] of sub-samples (4 per sample) -	+	+ +	+ + +	% infested total sub-samples per region
Northern	TOX 3107	4	5	8	3	0	
	Mandii	10	0	9	23	8	
	Kukulubehi	4	2	8	6	0	
	Rock	2	3	4	1	0	
	Total	20					80.0
Western	Agya Amoa	8	9	18	3	2	
	Red Rice	2	2	5	1	0	
	Total	10					72.5
Ashanti	Mr. More	4	5	9	2	0	
	08	1	3	1	0	0	
	Mr. Harry	2	5	3	0	0	
	Mandii	3	0	2	8	2	
	Total	10					67.5
Volta	Kawomo	2	6	2	0	0	
	Viono	1	4	0	0	0	
	WAB209-5-HB	3	7	5	0	0	
	Damansah	2	6	2	0	0	
	Adaisa	1	3	1	0	0	
	IDSA 85	1	4	0	0	0	
	Total	10					25.0

[1] - = no live nematodes found per 100 seeds, + = 1-29 live nematodes/100 seeds,
+ + = 30-99 live nematodes/100 seeds, + + + = > 100 live nematodes/100 seeds.

Table II. Effect of different seed treatments on population of *A. besseyi* in seeds of rice cv. Mandii.

Treatment	Nematodes/100 seeds		
	January 2003	March 2003	Average
Control	43	42	42.5
Ground pepper	6 (86.0)[1]	8 (80.9)	7 (83.5)
Ground carbofuran	9 (79.0)	10 (76.2)	9.5 (77.6)
Wood ash	11 (74.4)	13 (69.0)	12 (71.7)
Ground neem seed	8 (81.4)	7 (83.3)	7.5 (82.4)
LSD ($P < 0.05$)	17.2	16.7	
CV	8.5	8.3	

[1] In brackets are % reduction over control.
Data are means of three replicates.

Table III. Effect of treatments on the germination of seeds of the rice cv. Mandii.

Treatment	Number of germinated seeds/25		
	January 2003	March 2003	Average
Control	24.5 (98.0)	23.7 (94.8)	24.1 (96.4)
Ground pepper	19.2 (76.8)	18.6 (74.4)	18.9 (75.6)
Ground carbofuran	21.5 (86.0)	21.8 (87.2)	21.7 (86.6)
Wood ash	22.2 (88.8)	23.0 (92.0)	22.6 (90.4)
Ground neem seed	21.2 (84.8)	20.1 (80.4)	20.7 (82.6)
LSD ($P < 0.05$)	2.2	2.0	
CV	8.3	9.1	

[1] In brackets are % germination.
Data are means of three replicates.

by wood ash (Table II).

All treatments reduced seed germination (Table III). The average reduction for both tests was low (3.6%) in the control and was significantly greater (9.6-24.4%) for the other treatments, with ground pepper (24.4%) and ground neem seeds (17.4%) giving greater reductions than wood ash (9.6%) and carbofuran (13.4%).

DISCUSSION

The results showed that the botanicals and wood ash reduced the infection of rice seeds by *A. besseyi.* Previous reports on the nematicidal activity of pepper (*C. frutescens*) and neem (*A. indica*) seed powder have not referred to the white tip nematode of rice. Netscher (1981) demonstrated the nematicidal properties of neem against root-knot nematodes. Also, Chitwood (2002) reported that neem was nematicidal *in vitro* to *Meloidogyne incognita* (Kofoid *et* White) Chitw. and suggested that the utilization of phytochemicals in agricultural production could have significant potential in combating plant-parasitic nematodes. A significant reduction of population densities of *Pratylenchus brachyurus* Godfrey by some amendments in maize fields was also observed in Nigeria (Egunjobi and Larinde, 1975) and of *M. incognita* on *Withania somnifera* (L.) Dunal. in India (Pandey *et al.*, 2003). Johnson (1998) reported that the small-fruited hot peppers (*C. frutescens*) were resistant to the major species of root-knot nematodes.

Nematicidal activity against *A. besseyi* was discovered for the benzene extracts of roots of *Daphne odora* Thunb and the diterpenoid compound, odoracin (Chitwood, 2002). Wood ash has been reported to reduce the population of the yam nematode, *Scutellonema bradys* Steiner *et* Le Hew and also increase yield of water yam, *D. alata* L., in Nigeria (Adeniji, 1977). In many African countries, wood ash is commonly sprayed on vegetables in gardens to control various insect pests.

It is generally accepted that the use of nematicides is very effective for nematode control (Bakker, 1993). However, nematicides may cause groundwater contamination and can be toxic for the applicator (Thomas, 1996; Anonymous, 2000). In contrast, botanicals have not been associated with adverse effects on the environment, and their application presents few difficulties and does not require sophisticated apparatus. Comparatively, the strategy is cost-effective. Therefore, the use of

botanicals appears to be promising for the disinfestation of rice seeds and would be an alternative to banned nematicides, especially in poor farming systems, as in some areas of Ghana, and if used routinely.

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