Occurrence and distribution of white tip disease in deepwater rice areas in Bangladesh

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SUMMARY

White-tip disease of rice caused by the nematode *Aphelenchoides besseyi* Christie, 1942 is distributed in low to moderate levels of infestation in most of the deepwater rice areas in Bangladesh. The highest disease incidence with largest nematode population per plant was observed at the booting or flowering stage of the crop. Approximately 25 % of seed samples collected from farmers' seed stores or from fields at harvest, were found to be infested with this nematode. About 73.5 % infested seed samples had 5-25 nematodes/100 grains. Rajbowalia, a local variety, was found to be highly susceptible and had 273 to 1 031 live nematodes per 100 grains. Diseased panicles were significantly shorter, weighed less, had fewer filled grains and lower 1 000-grain weight than apparently healthy panicles.

RÉSUMÉ

Présence et répartition de la maladie du « white tip » dans les zones de culture du riz inondé du Bangladesh

La maladie du « white-tip » du riz causée par le nématode *Aphelenchoides besseyi* Christie, 1942 est répartie, avec des taux d'infestation faibles à modérés, dans la plupart des zones de culture du riz inondé du Bangladesh. La plus forte incidence de la maladie et les populations du nématode les plus élevées sont observées pendant les périodes de tallage et de floraison. Environ 25 % des échantillons de semences prélevés dans les greniers des paysans ou dans les champs, au moment de la récolte, sont infestés par le nématode. Environ 73,5 % des échantillons de semences contiennent 5 à 25 nématodes pour 100 grains. La variété locale Rajbowalia est la plus sensible avec 273 à 1 031 nématodes vivants pour 100 grains. Par rapport aux panicules saines les panicules infestées sont significativement plus courtes, plus légères, contiennent moins de grains pleins et le poids de 1 000 grains est plus faible.

White-tip disease of rice, caused by a seed borne nematode *Aphelenchoides besseyi* Christie, 1942, has been found in upland or irrigated rice in many rice growing countries in Asia, Tropical America, USSR and Africa (Franklin & Siddiqi, 1972; Fortuner & Williams, 1975; Ou, 1985). It has caused variable yield losses in different countries ranging from 14.5 to 46.7 % in Japan (Nishizawa & Yamamoto, 1951), 40-50 % in USA (Atkins & Todd, 1959), 29 to 46 % in Taiwan (Hung, 1959), 41 to 71 % in USSR (Tikhonova, 1966) and 20 to 60 % in India (Rao, Prasad & Panwar, 1985). Tamura and Kegasawa (1959) stated that if all stems of a hill were infected, the maximum yield loss would be 60 % from a susceptible variety in Japan.

In Bangladesh about 1.4 million hectares of land are devoted to deep-water rice which is broadcast in March-April and harvested in November-December. Its characteristic feature is an ability to elongate quickly under submerged conditions and an upturning of panicles (kneeing) during recession of water. The association of *A. besseyi* with deep water rice was first reported by Timm (1955) but he did not describe the characteristic symptoms of the disease nor the extent of its distribution in deepwater rice in Bangladesh. Recently its occurrence in several deep water rice areas has been noted (Rahman & McGeachie, 1982; Rahman, 1982; Rahman & Taylor, 1983).

Therefore a survey of *A. besseyi* in Bangladesh was undertaken and its symptoms under field conditions, the extent of its distribution in some selected deepwater rice areas, the levels of infestation in the farmers' seed stock and its effects on yield components were investigated.

Materials and methods

SYMPTOMS AND POPULATION DYNAMICS

Based on chlorotic discolouration of the leaf sheath just below the collar, 3 month-old seedlings of the deepwater rice cv. Rajbowalia were selected and marked by bamboo stakes for recording symptoms at different growth stages. Three samples, each of 25 stems or panicles showing symptoms were taken at each growth stage, the nematodes extracted, counted and their identity confirmed microscopically. Percentage of plants showing symptoms of the disease was estimated from 20×1 m^2 frame counts on each sampling day in the same field.

INCIDENCE AND DISTRIBUTION OF THE DISEASE

Fifteen different deepwater rice areas were selected based on easy access but representative of typical deepwater rice situations. Ten fields in each of these selected areas were surveyed randomly to record the number of healthy and diseased plants. The percentage of plants infested in each field was calculated using 20×1 m^2 frame counts. Infestations in farmers' seed stocks were also investigated at Manikganj, 80 km west of Dhaka : a few days before sowing, 196 seed samples of eighteen deepwater rice varieties were collected, representing 137 farmers form nine villages. Twenty seeds from each sample were split open and soaked overnight, the nematodes extracted were examined and identified microscopically. Based on the presence of nematodes, seed samples were indexed at different levels of infestation. The infestation level in the seed stocks (March/April) was compared with the actual infestation level in the field : 127 fields were surveyed at harvest (November-December) when ten panicle samples were taken from each field, the panicles threshed and nematodes identified and counted from twenty seeds. The index of infestation was estimated as before.

EFFECTS ON YIELD COMPONENTS

Ten apparently healthy panicles and ten panicles showing white-tip symptoms were collected from each of ten different white-tip infested fields planted with cv. Rajbowalia at Manikganj. Length and weight of these panicles were recorded and the panicles were threshed separately. Filled and sterile grains in each panicle were counted and then the grains of ten panicles were bulked from each field to obtain the 1 000 grain weight and also to estimate the nematode population in 100 grains.

Results

SYMPTOMS AND POPULATION DYNAMICS

Chlorotic discolouration in an area 0.5 to 2.0 cm on the leaf sheath just below the collar of 3 month-old seedlings was found to be the most diagnostic symptom under Bangladesh conditions. At the elongation stage, about a 2 to 5 cm length of the leaf tip of the affected plants appeared whitish. Also, chlorotic stripes along one edge of the affected leaf were always noticed. At the booting stage, the flag leaf of the affected plant was characteristically shortened, twisted, crinkled, and often distorted or split longitudinally. Complete or partial emergence of panicles occurred on infested plants with whitish spikelets on the tip or throughout. The affected spikelets were shrunken and unfilled.

Examination of plants throughout the growing season revealed that the highest nematode population occurred at the booting or flowering stage of the crop. The highest percentage of plant infestation were also observed at this stage. Both the nematode population per plant and the infestation percentage increased from the tillering stage to the booting stage and then declined at harvest (Fig. 1).

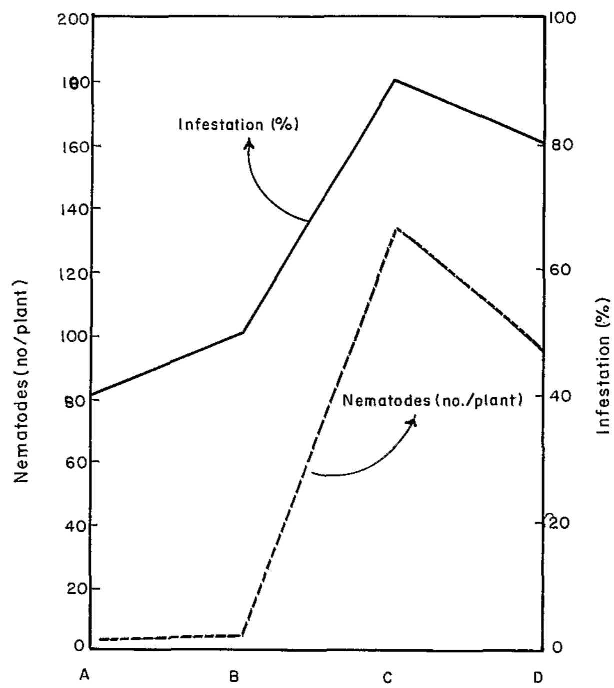

Fig. 1. Population dynamics of white tip nematode under different stages of deepwater rice and its relation with disease severity (A : Seedling stage; B : Tillering stage; C : Flowering stage; D : Harvest).

INCIDENCE AND DISTRIBUTION

The survey indicated that most of the deepwater rice areas were infested and that white-tip disease is widely distributed in Bangladesh. Among the fifteen areas examined (Fig. 2), ten areas were infested. Among the 461 fields examined, 112 fields (24.3 %) were infested. The severity of infestation in these fields was as follows : 88.4 % fields had low infestations (1-5 % plants infested/m^2), 11.6 % fields had moderate infestations (6-10 % plants infested/m^2), but no fields with higher infestation levels were recorded.

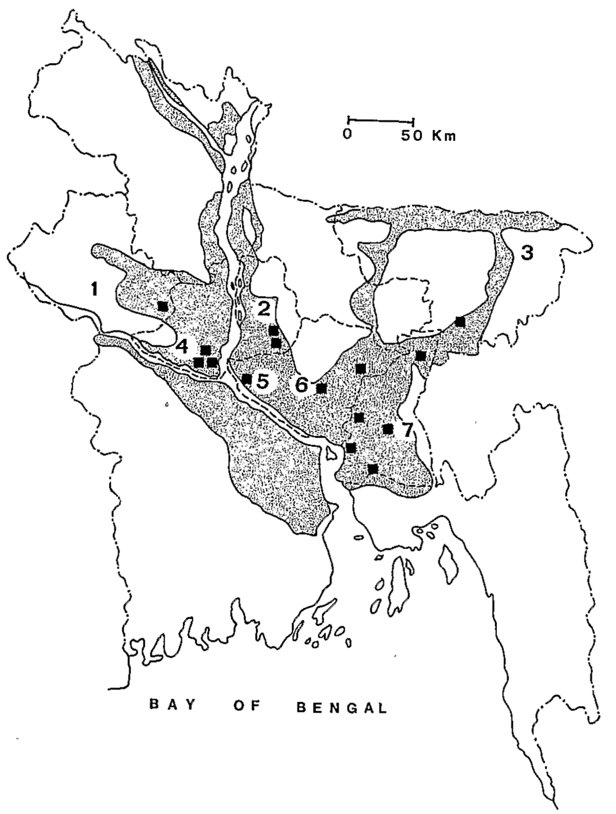

Fig. 2. Distribution of *Aphelenchoides besseyi* in selected deep-water rice areas of Bangladesh (■ = sampling places; district headquarters : 1 = Rajshahi; 2 = Tangail; 3 = Sylhet; 4 = Pabna; 5 = Manikganj; 6 = Dhaka; 7 = Comilla).

From this survey Moishakhali, Dubail, and Gozaria of Pabna, Tangail and Manikganj districts respectively were identified as the most important endemic areas for white-tip disease.

A total of 25 % of the stored seed samples and 22.8 % of the fresh seed samples examined were found to be infested with the white-tip nematode (Tab. 1). It was found that the cvs Bowalia, Digha, Hijoldigha, Rajbowalia, Molladigha and Dhepo, grown widely in Manikganj, were infested. Although the number of samples taken of Rajbowalia were low, this variety was found to be the most susceptible to white-tip nematode both in terms of infestation level and nematode numbers per 20 seeds (Tab. 1). It was also observed that fresh seeds always had fewer nematodes than stored seeds : a few samples had more than 100 nematodes/20 seeds, most of the samples having less than 20 nematodes/20 seeds. However, there were varietal differences both in infestation level and in the numbers of nematodes in seeds (Tab. 1).

Effect on yield components

The effects of *A. besseyi* on panicle yield in susceptible cv. Rajbowalia (Tab. 2) indicated that panicles with white-tip symptoms were significantly shorter by 30.43 % and lighter by 59.26 % than the panicles without disease symptoms. The diseased panicles had few filled grains and 69.5 % of grains were sterile. The weight of 1 000 grains from diseased panicles decreased by 65.44 % and the nematode population per 100 seeds in diseased panicles (1 031) was significantly higher than in panicles without apparent disease symptoms (273) (Tab. 2).

Discussion

Examination of deepwater rice plants at the vegetative stage, panicles at harvest and seed samples from farmers' store, indicated that the white-tip nematode is widely distributed in the deepwater rice areas of Bangladesh. The symptoms on leaves, e.g. whitening of the leaf tip during the vegetative stage, and the shortened, twisted and crinkled flag leaf seen during the reproductive stage of deepwater rice were similar to that reported in other types of rice (Yoshii & Yamamoto, 1950; Todd & Atkins, 1958; Muthukrishnan, Rajendran & Chandrasekaran, 1974; Ou, 1985). The chlorotic stripes along one edge of the leaf of an infested deepwater rice plant was noted for the first time as an important leaf symptom under Bangladesh conditions. The presence of nematode infested grains on the uppermost part of the panicle or throughout the panicle, together with the apparently healthy grains are in accordance with the report made for other types of rice (Steele, 1970). The cholorotic symptoms on the leaf are similar for both ufra and white-tip diseases but the whitening appears on the tip of the leaf for white-tip but starts at the base of leaf sheath for ufra : in white-tip the tip of the affected leaf becomes thin and thread-like.

The deepwater rice plants were less affected by *A. besseyi* during the tillering stage before flooding and the number of nematodes per infested plant was also low, which could be due to the slow rate of nematode development and multiplication under pre-flooded conditions. The reasons for the greater number of nematodes per plant and high infestation levels of plants during the flowering stage of the crop (at receding flood levels, Sept.-Oct.) were not investigated but it is possible that flood water, high atmospheric humidity and free moisture on the leaf surface during flood (June/July-Sept./Oct.) might play an important role in spread and multiplication of the nematodes. Maximum numbers of nematodes in grains at heading stage was also observed by Nandakumar *et al.* (1975). The apparent reduced infestation level at harvest could be due to the masking of symptoms on leaves as they die and dry out.

Examination of both the stored and fresh seed samples of deepwater rice revealed that more than 20 % seed samples were infested with *A. besseyi* and contained 10-615 nematodes per 100 grains (Tab. 1). Fukano (1962) in Japan, indicated that 30 or more live nematodes per 100 grains may be the possible economic threshold level in a susceptible cultivar. This would suggest that *A. besseyi* is causing yield loss of deepwater rice in the Manikganj area of Bangladesh, also with the susceptible cv. Rajbowalia (Tab. 1) in which a high level of grain sterility was found in diseased panicles.

Table 1

White-tip nematode infestation in farmers' stored seed and in fresh seed samples at harvest in Gozaria beel area, Manikganj)

Rice variety	*Number of seed samples infested with* A. besseyi		*% infestation with* A. besseyi		*Average numbers of* A. besseyi *per 20 seeds*	
	Stored	*Fresh*	*Stored*	*Fresh*	*Stored*	*Fresh*
Bowalia	8 (46)	6 (43)	17.4	14.0	21	12
Choto bowalia	3 (6)	2 (6)	50.0	44.3	11	4
Rajbowalia	2 (1)	6 (6)	100.0	100.0	123	18
Digha	7 (21)	7 (35)	33.3	30.3	8	7
Hijoldigha	15 (43)	3 (10)	34.9	33.3	25	6
Jhuldigha	3 (9)	2 (10)	33.3	20.0	7	4
Molladigha	2 (26)	1 (10)	7.7	10.0	103	8
Manikdigha	0 (1)	—	0.0	—	0	—
Dhepo	4 (26)	1 (4)	15.4	25.0	4	5
Sarsari	1 (3)	—	33.3	—	2	—
Modhusail	2 (6)	—	33.3	—	5	—
Dudsail	0 (1)	—	0.0	—	0	—
Morichful	2 (2)	—	100.0	—	100	—
Shamobhanga	0 (1)	—	0.0	—	0	—
Kaika	1 (1)	—	100.0	—	3	—
Jainga beez	0 (1)	—	0.0	—	0	—
Holud jaron	0 (1)	—	0.0	—	0	—
Rapladhan	0 (1)	—	0.0	—	0	—
Boron	—	0 (2)	—	0.0	0	—
Upchaga	—	1 (1)	—	100.0	—	15

Figures within the parenthesis are total seed samples.
— samples were not collected.

Table 2

Population density of white-tip nematode in rice grains and its influence on yield components in deepwater rice, cv. Rajbowalia.

Yield component	*Plant without disease symptoms*	*Plants with disease symptoms*	*Percent of increase (+) or decrease (—)*	*t - value*
Panicle length (cm) *	29.9	20.8	— 30.43	22.20**
Panicle weight (g) *	5.4	2.2	— 59.26	18.79**
Filled grain (no.)/panicle *	198.0	36.0	— 81.82	14.26**
Sterile grain (no.)/panicle *	22.0	82.0	+ 272.73	28.35**
1 000 grain weight (g)	21.7	7.5	— 65.44	15.33**
Nematodes/100 grains	273.0	1 031.0	+ 277.66	5.06**

** Significant at P = 0.01 level by t - test.
* Means of 10 samples.

As *A. besseyi* is seed borne, the nematode is easily transmitted from locality to locality. Under deepwater rice environments the nematodes could also be water dispersed from an infested field to a healthy field. Therefore the results suggest that seeds from infested areas should be treated before sowing to control and prevent further spread of the nematode in deepwater rice as is done with other types of rice.

ACKNOWLEDGEMENTS

This work was carried out under phase-1 of the ODA-BRRI Deepwater Rice Project and the authors acknowledge the assistance of the Overseas Development Administration of the Government of the United Kingdom.

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Accepté pour publication le 17 décembre 1988.