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An assessment of resistance in cultivars of *Oryza sativa* L. to *Aphelenchoides besseyi* Christie, 1942

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Summary. The rice leaf nematode *Aphelenchoides besseyi* is widely distributed and causes substantial reductions in crop yields in the rice-growing regions of Russia. Methods for controlling this nematode include the use of resistant cultivars. An assessment of 1003 rice cultivars from different ecologo-geographic origin for their resistance to *A. besseyi* was made in the glasshouse. Three cultivars were immune, 10 highly resistant, 164 moderately resistant and 826 susceptible and highly susceptible to *A. besseyi*. High and moderately resistant cultivars reduced nematode population levels but some development was observed with nematodes remaining at the end of vegetative period. The potential for using tolerant cultivars to control *A. besseyi* is discussed.

Key words: *Aphelenchoides besseyi*, resistance, rice, *Oryza sativa*, cultivars, nematodes.

White tip of rice, induced by the rice leaf nematode *Aphelenchoides besseyi* Christie, 1942, is widespread and causes substantial crop yields in the rice-growing regions of Russia. In the Povolzhe, Kuban and Rostov regions white tip of rice periodically is epiphytotic with infection of plants reaching 30-80% and yield losses of 0.5-1.8 ton/hectare (Tikhonova, 1974; Popova & Shesteperov, 1976).

In several countries control of this nematode disease has been achieved by using nematode resistant cultivars of *Oryza sativa* L. (Ou, 1985). In 1985 a breeding programme was established at the All-Russian Institute of Helminthology and the All-Russian Institute of Rice to produce nematode resistant cultivars of rice (Popova et al., 1989, 1991). The programme included the selection of potential sources and donors of rice resistance to *A. besseyi*. Here we present the results of an assessment of rice cultivars for their resistance to *A. besseyi* and the population dynamics of the nematode on the different cultivars.

MATERIALS AND METHODS

Rice cultivars from different ecological-geographical origins were obtained for assessment from the collection of the All-Russian Institute of Plant Production (Saint-Petersburg). Assessment of the cultivar resistance to the nematode was conducted in two stages. A primary assay was used to identify susceptible cultivars which were then rejected and a second assay tested only nematode resistance.

All experiments were conducted in the greenhouse under optimal condition for the growth and development of the rice plants (relative air humidity > 80%, air temperature 25-30° C). Plastic boxes (55 x 25 x 30 cm) were sown with 100 plants and in the primary assay the plant shoots were infected with nematodes using the sprinkle method (500.000 specimens/m^2). A total of 1003 rice cultivars were tested in the primary assay with 10 plants used for each cultivar. In the main assay the plants were inoculated with nematodes using plastic tubes 1.5-2 cm long x 2 mm dia. attached to the second or third leaf of the rice

shoot to which two drops of water suspension containing nematodes were added (c. 500 specimens per plant). Tubes were removed from the rice shoots after 3 days (Popova & Chizhov, 1984).

Resistance of the rice cultivars to *A. besseyi* was assessed by determining the numbers of nematodes recovered from the plants and the development of white tip symptoms, using a disease index scale (Popova et al., 1989; Popova, 1991), 110-120 days after inoculation. The following resistance rating was used:

0 - white tip symptoms and nematodes absent;

1 - white tip symptoms absent, nematode numbers, 1 - 10 per plant;

3 - white tip symptoms absent, nematode numbers > 10 per plant;

5 - white tip symptoms present, many nematodes present.

The average index of infection of each cultivar was estimated using the formula:

$$P = \frac{\Sigma (B \times n)}{N}$$

where:

Σ (B x n) - sum of the number of plants (n) and corresponding index of infection (B);

N - total number of the infected plants.

All varieties tested were classified in five different

Table 1. Results of an assay of rice cultivars for resistance to *Aphelenchoides besseyi* (Krasnodar population)

Cultivar	Origin	*Average index of infection	Nematode/plant average (min-max)	**Reaction
Bluebonnet	USA	0	0	I
Bluebonnet 50	USA	0	0	I
Starbonnet	USA	0	0	I
Norin 18	Japan	0.2	0.2(0-1)	HR
Norin 23	Japan	0.2	0.4(0-3)	HR
Vegold	USA	0.2	1.0(0-8)	HR
Teichung Native 1	Taiwan	0.2	1.1(0-10)	HR
Norin 29	Japan	0.3	0.3(0-1)	HR
Century Patna	USA	0.4	1.4(0-5)	HR
Very Lavoi KB-3	Mali	0.4	1.4(0-6)	HR
Belle Patna	USA	0.4	1.6(0-8)	HR
AC-27	India	0.4	2.0(0-5)	HR
Bluebelle	USA	0.6	1.2(0-4)	HR
Autumnal Rice	Viet Nam	1.1	6.0(0-35)	MR
Kaohsiung 21	Taiwan	1.1	8.0(0-50)	MR
Teichungsen 10	Cuba	1.2	15(0-50)	MR
Bhant dhan	Nepal	1.3	40(0-100)	MR
Son Khorcha	Nepal	1.5	18(0-60)	MR
Hamnam 2	KPDR	1.6	17(0-35)	MR
Hamnam 24	KPDR	2.1	25(0-67)	MR
D-273	USSR	2.2	70(0-300)	MR
D-458	USSR	2.3	55(20-110)	MR
Badmase	Nepal	2.5	33(0-140)	MR
No 2026	Uruguay	2.5	45(5-115)	MR
Arpa-shala	USSR	3.0	27(0-70)	MR
Taluli masino	Nepal	3.0	31(15-50)	MR
Estunam 38	Hungary	3.0	33(11-80)	MR
Bidry	Pakistan	3.0	50(30-110)	MR
Norin mochi 43-44	Japan	3.0	107(50-210)	MR
Start (Standart)	USSR	4.5	220(80-300)	S
Kulon (Standart)	USSR	5.0	310(50-500)	S

*See text for explanation and calculation of «index of infection».

**I - immunity, HR - highly resistant, MR - moderately resistant, S - susceptible.

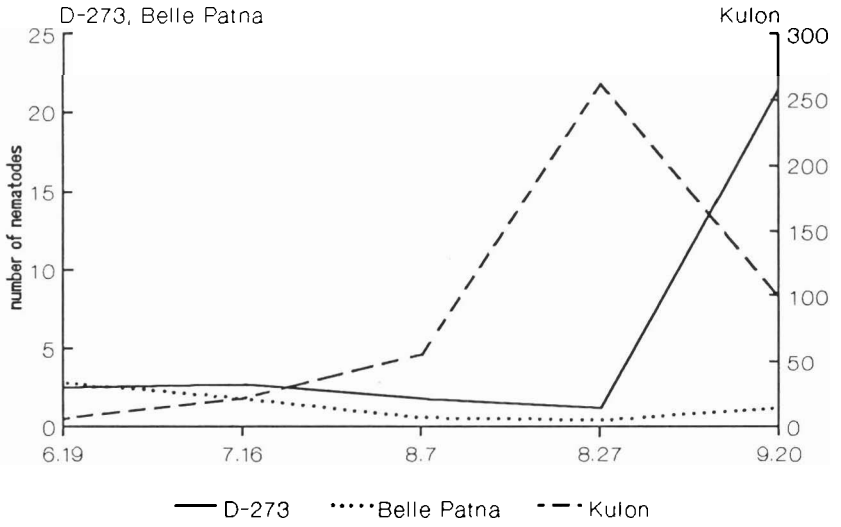

Fig. 1. Population dynamics of *Aphelenchoides besseyi* with three rice cultivars.

categories based on the average index of infection: 0 - immune, 0.1-1.0 - highly resistant, 1.1-3.0 - moderately resistant; 3.1-4.0 - moderately susceptible, 4.1-5.0 - highly susceptible.

Population dynamics of *A. besseyi* was studied with highly resistant (Belle-Patna), moderately resistant (D-273) and highly susceptible (Kulon) rice cultivars. The inoculum level was c. 200 nematodes per plant. Twenty five plants were harvested at 5 intervals and number of nematodes determined on each occasion.

The nematode population (Krasnodar) used for this study was cultivated by the method using the fungus *Alternaria tenuis* (Todd & Atkins, 1958; Tikhonova, 1967).

RESULTS AND DISCUSSION

From the 1003 rice cultivars 826 showed moderate or high susceptibility to *A. besseyi*. Moderate resistance was identified with 164 cultivars, 10 cultivars were highly resistant and 3 cultivars were total immune. The results obtained from the main assay are presented in Table 1.

Rice cultivars with high resistance or immunity to *A. besseyi* and white tip disease are important for breeding purposes. However, the results from our study showed that complete resistance to *A. besseyi* occurred only with the North American cultivars Bluebonnet, Bluebonnet 50 and Starbonnet but that Bluebelle, Bella Patna, Century Patna and Vegold were highly resistant, with only a small amount of nematode development occurring with these cultivars.

Immunity or high resistance was not present in rice cultivars from Russia which will undoubtedly complicate the breeding of nematode resistance cultivars for growing in the most northern region of cultivation of this crop.

The study of nematode population dynamics with different rice cultivars showed that in highly and moderately resistant cultivars nematode numbers were maintained at a low level throughout the vegetative period up to an average of three nematodes per plant (Fig. 1), but increased slightly in moderately resistant cultivar towards the end of the vegetative period.

In conclusion highly resistant cultivars to *A. besseyi* have been not found among cultivars originating from Russia, however tolerant cultivars may be recommended for cultivation. Nematodes reproduce successfully on tolerant cultivars, but do not seriously affect plant productivity. For example, when relatively large nematode numbers (50 to 300 per plant) are present with tolerant plants the seed weight of whisks decreased by less than 15% as compared to the control whereas in susceptible cultivars in 30-70% reduction was recorded (Popova et al., 1980).

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Попова М.Б., Зеленский Г.Л., Субботин С.А. Оценка сортов риса *Oriza sativa* L. на устойчивость к *Aphelenchoides besseyi* Christie, 1942.

Резюме. Рисовая листовая нематода *Aphelenchoides besseyi* широко распространена и вызывает значительные потери в рисосеющих районах России. Перспективным методом борьбы с нематодой является внедрение устойчивых сортов. Проведенные в теплице испытания 1003 сортообразцов риса различного эколого-географического происхождения показали, что 3 образца можно отнести к иммунным, 10 - к высокоустойчивым, 164 - к среднеустойчивым и 826 - к восприимчивым и сильновосприимчивым. Численность нематод в растениях высоко- и среднеустойчивых сортов сохраняется низкой в течение вегетации, однако может незначительно возрастать в его. Обсуждается возможность применения выносливых сортов риса для борьбы с рисовой нематодой.