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Resistance of rice cultivars to white tip disease caused by *Aphelenchoides besseyi* Christie

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Aphelenchoides besseyi is a seed-borne plant parasitic nematode and is widely distributed in most rice growing areas. Application of resistant cultivars requires the identification of resistance source, which can then be included in breeding programs to improve the local rice cultivars. Fourteen Iranian rice genotypes including improved and local varieties were evaluated for resistance to *A. besseyi* in greenhouse condition. Screening for resistance carried out based on symptom expression and nematode populations. Among the cultivars tested, Binam, Domsiah, Khazar and Hassansarayi showed high resistance. Moderate resistance was identified with Sepidroud, Kadus, Hassani and Ramezani. Hashemi, Deilamani and Alikazemi were moderate susceptible and Tarom, Nemat and Neda ranked as high susceptible to nematode. Susceptible plants expresses also other typical symptoms such as shortening of flag leaf which twisted at apical portion and hinders the emergence of panicle, reduction of panicle length and the grain number, spikelets with distorted glumes and deformed kernels. Sometimes symptomless but infested plants were also found.

Key words: *Aphelenchoides besseyi,* cultivar resistance, white tip, rice

Introduction

White tip disease of rice, caused by *Aphelenchoides besseyi*, has been reported in irrigated rice in many rice growing area in north of Iran (Jamali *et al.* 2007). Due to increasing concern about environmental contamination by pesticides, plant resistance and tolerance to plant parasitic nematodes have increased in importance during the past decades.

Resistance to *A.besseyi* appears to be widespread. Cralley (1949) and Cralley and Adair (1949) first reported variations in susceptibility of rice to *A. besseyi* and listed the cvs Arkansas Fortuna, Nira 43 and Bluebonnet as

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resistant. Resistance to *A. besseyi* has been reported from Japan (Nishizawa, 1953), Korea (Park and Lee, 1976), India (Rao *et al*., 1986), Brazil (Oliveira, 1989), Russia (Popova *et al*., 1994) and Italy (Giudici *et al*., 2003).

In Russia, an assessment of the resistance to *A.besseyi* of 1003 rice cultivars from different regions was made in the glasshouse. Three cultivars were immune, ten were highly resistance, 164 were moderately resistant and 826 were susceptible or highly susceptible to *A. besseyi* (Popova *et al*., 1994). Several cultivars with multiple resistances to *A. besseyi* and other important pathogens of rice were found. Pecos rice is not only resistant to *A. besseyi* but also to the viral disease hoja blanca and to the fungal disease rice blast and rice brown spot (Bollich *et al*., 1985). Namyeongbyeo, bred from crosses involving Milyang 40, Milyang 43, IR10157 and IR5533, is not only moderately resistant to *A. besseyi* but also to several virus diseases, the bacterial disease rice leaf blight, rice blast and several rice leaf and plant hoppers (Sohn *et al*., 1987). In the USA, the progenitors of almost all the resistance varieties bred in the last 40 years are Fortuna, Nira, Bluebonnet and in particular Rexoro (De Waele, 2002).

A goal of the Iranian Rice Institute Research is to help rice farmers get the best results from their crops. Since the occurrence of the disease, nematode distribution has been increased in rice fields and apparent symptoms due to nematode infection have been observed. The aim of this research was to evaluate white tip resistance of rice cultivars. The knowledge of resistance variety can be helpful to find source of resistance.

Materials and methods

Preparation of nematodes

Aphelenchoides besseyi was isolated from infected seeds collected from rice fields in Guilan province, north of Iran. Nematodes were extracted according to Coolen and D'Herde's method (Coolen and D'Herde, 1972). *A. besseyi* can be cultured on various fungi. In this study, the nematode multiplied on *Alternaria alternata* cultured on PDA (potato dextrose agar) because the highest reproduction was achieved on it (Jamali *et al*., 2008).

Plant material and cultural conditions

Rice cultivars combined improved and local varieties were obtained from the collection of the Iranian Rice Institute Research (Rasht). The experiments were carried out in greenhouse conditions with an average air temperature ranging from 28 ºC to 30 ºC and relative humidity ranging from 85% to 90%.

Rice seedlings were inoculated by plastic tube method at booting stages with 500 nematodes per plant (Jamali *et al*., 2006). Bioassays were arranged in completely randomized design with four replications during 2008-2009. The experiment included the cultivars 'Neda', 'Nemat', 'Kadus', 'Sepidroud', 'Khazar' and 'Ramezani' which are improved cultivars and 'Tarom', 'Alikazemi', 'Hashemi', 'Hassani', 'Binam', 'Deilamani', 'Domsiah' and 'Hassansarayi' which are local varieties.

Disease evaluation

White tip symptoms were recorded after three to six weeks of inoculation and Population of nematodes were measured at the end of growing season. Resistance of the rice cultivars to the nematode was assessed by counting the numbers of nematodes recovered from the plants and the development of white tip symptoms, using a diseases index scale (Popova *et al*., 1989; Popova, 1991; Popova *et al*., 1994).

The resistance rating was used as followed:

0- White tip symptoms and nematodes absent.

1- White tip symptoms absent and nematode numbers 1-10 per plant.

3- White tip symptoms absent and nematode numbers >10 per plant.

5- White tip symptoms present and many nematodes present.

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

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

$\sum (B \times n)$: 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 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.

Results and discussion

On the basis of the symptom expression, the tested varieties can be ranked as follows. Binam, Domsiah, Khazar and Hassansarayi showed high resistance. Moderate resistance was identified with Sepidroud, Kadus, Hassani and Ramezani. Hashemi, Deilamani and Alikazemi were moderate susceptible and

Tarom, Nemat and Neda ranked as high susceptible to nematode. The results obtained from this assay are presented in Table 1.

The results showed that highly resistance occurred only with four cultivars and they are important for breeding process. However, Khazar as high yielding cultivar showed multiple resistances. Khazar rice is not only resistant to *A. besseyi* but also to the fungal disease blast (*Pyricularia oryzae*) in leaf stage. Neda and Nemat as improved cultivars were highly susceptible and large amount of nematode development recorded with these cultivars (Table 1).

Rice plants infested by the nematode exhibit different reaction. Susceptible plants express also other typical symptoms such as shortening of flag leaf which twisted at apical portion and hinders the emergence of panicle, reduction of panicle length and the grain number, spikelets with distorted glumes and deformed kernels, production of tillers from the uppers nodes (Fig. 1). However, infested plants may not exhibit any typical symptoms.

Table 1. Results of assessment rice cultivars for resistance to *Aphelenchoides besseyi*.

Cultivar	Reaction	Average index of infection	Nematode/Plant Average (min- max)
Khazar	HR	0.6	3.2 (0-20)
Domsiah	HR	0.7	4.1 (0-25)
Hassansarayi	HR	0.8	4.78 (0-25)
Binam	HR	0.9	6.25 (0-35)
Hassani	MR	1.5	34.82 (0-120)
Sepidroud	MR	1.9	45.36 (0-140)
Ramezani	MR	2.4	58.31 (0-180)
Kadus	MR	2.9	66.2 (0-190)
Deilamani	MS	3.1	74.41 (0-200)
Hashemi	MS	3.3	85.9 (0-210)
Alikazemi	MS	3.7	98.72 (0-220)
Tarom	HS	4.1	127.1 (0-250)
Nemat	HS	4.4	141.6 (0-300)
Neda	HS	4.7	170.15 (0-350)

HR: Highly Resistant, MR: Moderately Resistant, MS: Moderately Susceptible, HS: Highly Susceptible.

Fig. 1. Typical symptoms on different high susceptible cultivars A. Neda B.Nemat C. Tarom.

The use of nematicides to control nematodes has adverse environmental effects and is too costly for subsistence farmers. A promising alternative is the use of nematode-resistant varieties. Such varieties can be obtained by selecting for the highest available resistance from among existing genotypes or by classical breeding. In both cases, the first step is the screening of germplasm for sources of resistance to nematodes. Resistance to *A. besseyi* is said to be genetically controlled and carried by the Japanese cv. Asa-Hi (Nishizawa, 1953).

Although reproduction is important in determining resistance but it is not the major criterion to use in determining nematode pathogenicity. Plant response in terms of symptom development should also be evaluated.

Measurements of plant characteristics of fourteen tested rice cultivars indicated that most cultivars grown in north of Iran are susceptible to *A. besseyi* which emphasize the need for breeding local cultivars. Four tested varieties, Binam, Domsiah, Khazar and Hassansarayi were highly resistant. Among them Khazar showed complex resistance to rice blast and white tip nematode. Therefore, it could be included into the IPM program for control of the nematode. In the USA, *A. besseyi* has been controlled principally through the use of resistant cultivars (Bridge *et al*., 2005). The complete resistance to the nematode occurred only with the North American cultivars Bluebonnet, Bluebonnet 50 and Starbonnet (Popova *et al*., 1994).

In Iranian susceptible cultivars, the flag leaf was characteristically shortened, twisted and often distorted. Complete or partial emergence of panicles occurred on infested plants with whitish spiklets on the tip or throughout. The affected spikelets were shrunken and unfilled (Fig.1). Italian rice varieties ranked in three groups on the basis of different leaf symptoms: 1. typical whitening of leaf tip, 2. chlorotic streaks or strips on leaves observed with back light, 3. no leaf symptoms in stunted plants with panicle partially emerged and reduced size (Giudici *et al*., 2003).

A promising method for nematode control is the development and deployment of nematode resistant rice cultivars. Highly resistance cultivars to the nematode have been not found cultivars originating from some regions, however tolerant cultivars may be recommended for cultivation. Tolerant cultivars support nematode development and reproduction without serious plant growth reduction.

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