Screening for Seedling Resistance to Rice Yellow Mottle Virus in Some Rice Cultivars in Sierra Leone

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ABSTRACT

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Six hundred rice accessions (*Oryza sativa*) were screened for resistance to rice yellow mottle virus at the seedling stage. The trial was conducted for 4 years using a finger rub inoculation technique in a rain-fed upland nursery at Rokupr, in northwestern Sierra Leone. Most of the currently recommended rice cultivars, farmers' traditional cultivars, and introductions were susceptible to this sap-transmissible virus. Most of the resistant or tolerant accessions were rices with a long history of cultivation in Africa or were progenies derived from them. These resistant rices invariably also possessed horizontal resistance to blast (*Pyricularia oryzae*), the most widespread disease of rice in West Africa. This observation makes them useful sources of resistance to both rice yellow mottle virus and the rice blast for cultivar improvement.

Additional keywords: mangrove swamp

A disease of rice caused by rice yellow mottle virus (RYMV) has been reported from several East and West African countries (e. g., Kenya, Guinea, Côte d'Ivoire, Liberia, Nigeria, and Sierra Leone) (1,3,4,10,13). The virus is very stable and is sap-transmissible with polyhedral particles of about 28 nm in diameter. It is spread mainly by adult leaf-feeding beetles in the family Chrysomelidae (2,6,11). The relationship between RYMV and other isometric plant viruses of comparable size is not known.

In Sierra Leone, the disease is endemic to rice grown in valley bottoms where volunteer rices and ratoons or rice regrowths from previously harvested crops favor survival of the virus during the off-season (12). Rice yellow mottle virus has also been successfully transmitted to *Eleusine indica* Gaertn. and *Echinochloa crus-galli* (L.) P. Beauv. at Rokupr (11). Presumptive symptoms of the virus were also observed on a wild rice (*Oryza longistaminata* Chev. & Roehr.) in a freshwater swamp adjacent to a mangrove swamp at Rokupr, and in mangrove swamps at Bissau and Caboxanque in the Republic of Guinea Bissau (S. N. Fomba, *unpublished*). The virus has also been reported on irrigated rice. However, it occurs sporadically in rain-fed uplands, mangrove swamps, and other rice areas in Sierra Leone. The disease has also been observed on cultivated rice in mangrove and adjacent freshwater swamps at Coyah and Koba in the Republic of Guinea. The virus is not known to be seed-transmissible.

Mangrove swamp rice refers to rice grown on swampland reclaimed from mangrove vegetation such as *Rhizophora* and *Avicennia* spp. on the banks of tidal rivers, creeks, and on the seacoast. These rice lands are inundated twice a day throughout the year by tidally influenced floods. However, they are sufficiently refreshed by rainwater and river floods during the rainy season (May through November) to allow a crop of rice to be transplanted on them (7,8). Mangrove swamp rice culture is also referred to as tidal swamp rice because of the tidal effect on these rice lands. Rice is usually transplanted on them from mid-July to October each year when the salts, mainly NaCl, have been leached from the topsoil by direct rainfall and/or freshwater floods.

In view of the increasing incidence of RYMV in rice in West Africa and its potentially destructive nature (5), this study was done to determine the resistance of some rice accessions (*O. sativa*) to RYMV at the seedling stage in a rain-fed upland nursery.

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MATERIALS AND METHODS

Six hundred accessions of recommended and farmers' traditional rice cultivars, introductions, and advanced breeding lines were screened for resistance to RYMV for 4 years beginning in 1982 at Rokupr, in northwestern Sierra Leone. The materials were sown in well-harrowed, gravelly, upland nursery beds 10 × 1 m.

The seeds were drilled at the rate of 10 g/100 cm of row per entry with 20 cm of separation between rows. The nursery beds were fertilized with NPK at 80, 40, or 60 kg/ha. The phosphorus and potassium were applied at seeding, and the nitrogen was drilled in three split applications of urea between rows at 2 wk intervals after seeding.

The inoculum was prepared by macerating 22.5 g of freshly infected young rice leaves in 1 L of 0.01-M phosphate buffer, pH 7.0, in a Waring Blendor. The infected leaves were obtained from rice plants previously inoculated with the virus and maintained in a screenhouse at Rokupr. The homogenate was sieved through cheesecloth, and fine grade Carborundum was added at 2–3 g/L of inoculum. A 50-cm half-row of 4-wk-old test seedlings was inoculated using a finger rub inoculation technique (11) where a piece of cotton wool dipped in the inoculum was rubbed on all leaves of test seedlings to ensure optimum wetting. The remaining 50 cm of each row was inoculated only with the buffer solution to serve as control. Ten plants were randomly selected and their heights were measured from the ground level to the tip of the tallest leaf 2 and 4 wk after inoculation. The mean plant heights of the control and treated plants were determined, and the percentage of stunting of inoculated plants was calculated with reference to the control. These data were grouped into four classes of increasing severity of stunting: 1 = 0–5% stunting; 2 = 5.1–25% stunting; 3 = 25.1–45% stunting; and 4 = more than 45% stunting. A score of 1 was rated resistant (R); 2, moderately resistant (MR); 3, moderately susceptible (MS); and 4, susceptible (S). Susceptible cultivars like ROK 8 routinely gave a stunt reaction of 4 when compared with buffer-inoculated controls.

Visually assessed color reactions were categorized according to the scale devised by Raymundo et al (11), but modified to stress the importance of stunting in affected plants due to the virus. A cultivar was classified as exhibiting faint mottling (FM) when leaf streaking and mottling were faint or hardly discernible. The category mild mottling (MM) was used for mild streaking or mottling, while severe mottling (SM) and/or chlorosis was used for rice cultivars exhibiting severe streaking, mottling or chlorosis, oranging, bronzing, and crinkling, often with the subsequent death of affected seedlings. However, none of the rice cultivars and lines chosen for use in varietal improvement to RYMV exhibited severe mottling, streaking, or chlorosis.

The effect of RYMV on plant height and symptom development was then combined into an overall rating in which the cultivar or line was classified as resistant (R) when it was rated 1 for stunting and FM for color symptoms; moderately resistant (MR) with 2 for stunting and MM for color symptoms; and moderately susceptible (S) with a stunt rating of 3 and MM symptoms.

Rice accessions that exhibited overall ratings of susceptible (S) with a stunt rating of 4 and SM symptoms were discarded. The reaction classes MR and MS were designated as tolerant to RYMV.

RESULTS AND DISCUSSION

Even the resistant or tolerant cultivars and lines varied considerably in resistance to stunting, an easily quantifiable reaction (Table 1). This was most likely due to cultivar characteristics, because all the test materials were managed similarly. Color reactions ranged from mild, barely discernible mottling in resistant cultivars to severe mottling or chlorosis and associated oranging, bronzing, leaf narrowing, and crinkling symptoms on susceptible ones. Distinct leaf mottling was often observed 4–6 days after inoculation of susceptible cultivars or lines.

Most of the accessions tested (e.g., ROK 5, ROK 7, and ROK 8) were susceptible to the virus during the seedling growth stage and are recommended cultivars for mangrove swamps in Sierra Leone. Most of the resistant or tolerant cultivars or lines were materials with a long history of cultivation in Africa or were progenies derived from them (Table 1), as observed by others (6,11). The resistance shown by these rices (*O. sativa*) to RYMV was probably due to their coadaptation with the virus over a long period of time. Rice yellow mottle virus is most likely indigenous to Africa.

The resistant or tolerant cultivars or lines (e.g., IRAT 13, IRAT 110, LAC 23, and ROK 16) survived to flower and produce seeds in the nursery after inoculation with the virus, but the susceptible cultivars or lines were often killed. The resistant or tolerant cultivars or lines (e.g., IRAT 13, LAC 23, and TOX 502-11-SLR) almost always also possessed horizontal resistance to the rice blast disease (*Pyricularia oryzae* Cav.) (S. A. Raymundo and S. N. Fomba, *unpublished*). Blast is the most important disease of rice in West Africa (9). This observation makes these rice cultivars or lines useful sources of resistance to both the virus and rice blast diseases for cultivar improvement purposes.

The need for developing cultivars resistant to RYMV cannot be overemphasized, particularly as the virus continues to gain prominence in all rice areas in West Africa, especially in irrigated and valley-bottom rice cultures. Furthermore, the rapid introduction, evaluation, and promotion of new rice technologies in all rice areas in West Africa, including nitrogen fertilization and use of high-yielding but virus-susceptible rice cultivars, may create conditions favorable for the spread of the disease, reminiscent of the spread of rice virus diseases in Southeast Asia in the mid-1960s (M. Yoshimeki, *unpublished*). Concerted efforts by pathologists, breeders, and entomologists are, therefore, needed to develop cultivars resistant to both RYMV and its beetle vector, *Chaetocnema* spp., to ward off the potential danger.

Table 1. Reactions of rice cultivars and advanced breeding lines (*Oryza sativa*) to rice yellow mottle virus[a] at the seedling growth stage in a rain-fed upland nursery at Rokupr, Sierra Leone, 1982–1985

Cultivar or line	Parentage	Origin[b]	Disease index		Overall reaction[e]
			Stunting[c]	Mottling[d]	
IRAT 13	63-83 Mutant	CI	1	FM	R
IRAT 104	IRAT 13 × Moroberekan	CI	3	MM	MS
IRAT 109	IRAT 13 × IRAT 10	CI	2	MM	MR
IRAT 110	IRAT 13 × IRAT 10	CI	2	MM	MR
IRAT 132	IRAT 13 × Moroberekan	CI	3	MM	MS
IRAT 138	IRAT 13 × R 75	CI	2	MM	MR
IRAT 144	IRAT 10 × IRAT 13	CI	3	MM	MS
ITA 116	63-83 × IR 773-A1-36-2-1	N	3	MM	MS
ITA 117	13A-18-3-1 × TOX 7 × 7-4-2-5-2	N	3	MM	MS
ITA 162	Moroberekan × (ROK 1, Suakoko 8, TOX 7)	N	3	MM	MS
TOX 502-11-SLR	63-83 × TOS 4644 × Dourado Precoce × TOS 4163	N	3	MM	MS
TOX 515-11-SLR	Lita 506 × TOS 4195	N	2	MM	MR
Gissi 27	Local selection	L	2	MM	MR
LAC 23	Local selection	L	1	FM	R
ROK 16	Local selection	SL	2	MM	MR
Angkata	Local collection	SL	2	MM	MR
Pa Kpenyei (Red) 191	Local collection	SL	2	MM	MR
Pa Miniku 33[B]	Local collection	SL	2	MM	MR
Nyowai	Local collection	SL	2	MM	MR
WAR 25-14-1-2	Bathurst × SR 26[B]	SL	2	MM	MR
WAR 25-16-4-1	Bathurst SR 26[B]	SL	2	MM	MR
WAR 25-22-2-1	Bathurst × SR 26[B]	SL	2	MM	MR
WAR 27-4-3-1	BRJ 51-17-3 × Pa Mabinty	SL	2	MM	MR
WAR 30-18-4-2	Mashuri × Dama Barawa	SL	2	MM	MR
WAR 36-40-4-2	Pa Momoh Gbinteh 73 × Jhingasail	SL	2	MM	MR
WAR 39-36-1-2	Pa Sorro White 53 × BR 43-11-2	SL	2	MM	MR
WAR 39-50-2-2	Pa Sorro White 53 × BR 43-11-2	SL	2	MM	MR

[a] Originally designated pale yellow mottle virus by Raymundo et al (12), but was identified later as rice yellow mottle with an antiserum obtained from the International Institute of Tropical Agriculture, Ibadan, Nigeria (13).
[b] CI = Côte d'Ivoire, N = Nigeria, L = Liberia, and SL = Sierra Leone.
[c] 1 = 0–5% stunting; 2 = 5.1–25% stunting; and 3 = 25.1–45% stunting.
[d] FM = faint mottling and MM = mild mottling.
[e] Overall reaction classes were defined as follows: R = resistant, score 1 for stunting, and FM for color symptoms; MR = moderately resistant, score 2 for stunting, and MM for color symptoms; and MS = moderately susceptible, score 3 for stunting, and MM for color symptoms.

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