Diseases of upland rice and their control through varietal resistance

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DISEASES OF UPLAND RICE

The basic diseases of upland rice are similar to those of flooded lowland rice. The absence of flood water, however, creates around the plants a different type of microclimate, one that favors the development of certain diseases. Soil-borne pathogens, for example, are more active, and cause more severe problems, in upland than in lowland rice.

Rice blast, caused by ***Pyricularia oryzae,*** is the most serious disease found in the extensive upland rice areas of Latin America, Africa, and Southeast Asia. The microlimate around upland plants appears to directly favor blast disease, although some early experiments indicate that high blast susceptibility might be caused by the reduced uptake of silica.

Sheath blight disease, caused by the soil-inhabiting fungus ***Rhizoctonia solani (Thanatephorus cucumeris,*** commonly known as ***Corticium sasakii),*** may become increasingly serious as more fertilizers and other improved cultural practices are used on upland rice. The fungus is not active in flooded soil, but it will grow and multiply throughout the year in upland soil. It has a wide host range.

Seedling diseases, seldom a problem in lowland transplanted rice, may be important in direct-seeded upland rice. Soil-borne fungi and bacteria may cause seed decay or may attack the young seedlings.

Bacterial leaf streak ***(Xanthomonas translucens*** f. sp. ***oryzicola)*** is frequently found in upland rice, but seldom causes much damage.

Little information is available on bacterial blight ***(X. oryzae)*** in upland rice. We don't know if the disease can be transmitted through rice seeds. Under upland conditions, however, bacterial blight cannot be spread by irrigation water, so it may not be as destructive as in lowland rice.

Incidences of tungro and grassy stunt diseases seem to be similar for both upland and lowland rice. We don't know, however, the effect of the upland microclimate on the populations of the insect vectors.

Many more species of nematodes attack upland rice than lowland rice. In Japan, the cyst nematode was reported to have caused continuous cropping to fail in upland rice. In Liberia, cyst nematode severely damaged a small experimental plot of upland rice after continuous cropping. The International Institute of Tropical Agriculture, Ibadan, Nigeria, has stated, "Rice grown at IITA under upland conditions was generally infected by plant parasitic nematodes. The spiral nematode was distributed in all plantings in large numbers. The root-knot nematode, the root-lesion nematode, and the pin nematode occurred in less than 10 percent of the samples. One planting of five rice varieties in soil infested with the root-lesion nematode (55%) and the spiral nematode (45%) had 31,000 nematodes per plant 6 weeks after planting. All five varieties were more or less equally infected. IR20 rice grown on soil fumigated with D-D mixture to control the spiral nematode gave a 25.4-percent increase in yield over non-fumigated plots. IR665-79-2 showed no increase in the same trial.''

Because microclimate in upland and lowland rice differ, the severity of other diseases may also differ.

VARIETAL RESISTANCE

Rice varieties that are resistant to various major diseases of lowland rice should also be useful for breeding resistance to upland rice.

Good sources of resistance to blast have been identified by the international blast nurseries (Table 14). Many have been crossed with semidwarf varieties or lines. Among the commonly used donor varieties are Tetep, Tadukan, C46-15, Carreon, Mamoriaka, Dawn, Kataktara DA2, and others. Some hybrid lines combine several sources of resistance to blast. A few such lines tested in upland trials in the Philippines were also good yielders. An example is a line from the complex cross IR8/Dawn//IR8/Kataktara DA2.

Table 15 lists varieties resistant to bacterial blight. From these sources, many new varieties or lines that are resistant to bacterial blight – among them IR20, IR22, IR26, and several unnamed

Table 14. Resistant varieties selected from international blast nurseries.[a]

Variety	Origin	Total tests 1964–1973	Susceptibility index	Resistant frequency (%)
		Group I		
Tetep	Vietnam	302	1.24	98.0
Nang Chet Cuc	Vietnam	262	1.64	88.3
C46-15	Burma	307	1.56	93.8
Tadukan	Philippines	306	1.50	94.5
Trang Cut L. 11	Vietnam	263	1.70	94.3
Pah Leuad 111	Thailand	258	1.57	94.3
H-5	Sri Lanka	314	1.71	92.7
R-67	Senegal	291	1.85	92.4
CI 7787	U.S.A.	278	1.83	91.7
Mekeo White	New Guinea	276	1.94	92.8
Ram Tulasi (Sel)	India	297	1.70	91.9
D25-4	Burma	292	1.73	93.6
M-302	Sri Lanka	310	1.86	90.3
Padang Trengganu 22	Malaysia	236	1.93	87.4
Ta-poo-cho-z	China	277	1.61	91.3
Susceptible varieties:				
Kung-shan-wu-shen-ken	China	246	4.30	24.4
Fanny	France	252	4.39	19.4

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(Table 14 *continued*)

Variety	Origin	Total tests 1964–1973	Susceptibility index	Resistant varieties (%)
		Group II		
C46-15	Burma	229	1.51	97.3
Mamoriaka	Malagasy	227	1.48	97.8
Carreon	Philippines	227	1.38	97.4
Huan-sen-goo	China	216	1.35	96.3
Dissi Hatif	Senegal	223	1.51	91.3
Ram Tulasi	India	211	1.41	97.2
Ram Tulasi (Sel)	India	194	1.42	97.3
Thava Lakkanan PTB 9	India	222	1.52	96.9
Macan Tago	Philippines	155	1.75	95.5
Ahmee Puthe	Burma	136	1.49	97.1
Ca 435/b/5/1	Indonesia	205	1.56	97.1
DNJ-60	Bangladesh	224	1.93	93.8
Ca 902/b/2/2	India	219	1.60	94.5
R-67[b]	Senegal	202	1.64	94.6
N-12[b]	Japan	225	1.80	93.9
Pah Leuad 29-8-111	Thailand	220	1.65	95.5
T 23	India	220	1.74	94.4
DZ-193	Bangladesh	231	1.19	94.4
Pi-4	Japan	166	1.54	93.9
Ca 902/b/3/3/1	Chad	226	1.60	94.7

[a]Group I consists of 258 varieties selected at random and tested in IBN since 1963; Group II consists of 321 varieties selected from more than 8,200 varieties after repeated tests at IRRI and was entered in IBN since 1965. [b]Upland varieties.

Table 15. Sources of resistance to bacterial blight (BB): tall donor parents and their semidwarf progenies (1972 and 1973 International Bacterial Blight Nursery).

Tall resistant donor	Semidwarf progeny	Cross[a]	BB disease rating[b]			Resistance or tolerance to other diseases and insects[c]
			NE Asia	SE Asia	South Asia	
			Single recessive gene[d]			
BJ1	–	–	R	MR	R-MS	BLS, B, T, SB
BJ1	RP291-18-60	IR8/BJ1	R	R	MR-S	BLS, GLH
BJ1	RP633-150-6-5	IR22//IR8/BJ1	R	R	X	
DZ 192		–	R	MR	MS-S	8⊥S
DZ 192	IR1545-339	IR24/DZ 192	R	MR	MX-S	8⊥S, Ɛ⊥H
			Single dominant gene			
Sigadis		–	MR	MR	MS	B, T
Sigadis	IR1529-680-3	IR305/IR24	MR	MR	MR-MS	B, 8⊥S, GLH
TKM 6	–	–	–	R	MX-MS	B, GLH, T
TKM 6	IR20	IR262/TKM6	MR	MR	∀X-MS	B, GLH, T, SB
TKM 6	IR26	IR24/TKM6	R	MR	MR-MS	B, BPH, GLH, T, SB
TKM 6	IR2061-464	IR833//IR1561/1737				B, T, GSV, BPH, GLH, SB
W1263		–	MR	MR-MS	MR-S	T, BPH, GLH, SB, GM
W1263	IR2031	–	–	MR	–	T, GSV, BPH, GLH, GM
Wase Aikoku		–	–	MR	MX-S	
Wase Aikoku	IR1697-42-2-2	$IR8^2$/Wase Aikoku	MR	MR	MS	

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(**Table 15** *continued*)

Tall resistant donor	Semidwarf progenies	Cross[a]	BB disease rating[b]			Resistance or tolerance to other diseases and insects[c]
			NE Asia	SE Asia	South Asia	
			Other tall varieties with no advanced dwarf progenies – Inheritance of resistance			
Lacrosse x Zenith-Nira	–	–	–	MR	MR-S	
Malagkit Sungsong	–	–	MR	MR	MR-MS	
Nagkayat	–	–	R	MR	MR-MS	
Remadja	–	–	MR	MR	MR-MS	GLH, T
Semora Mangga	–	–	–	R	MR	

[a]/ = first cross; // = second cross. [b]R = resistant; MR = moderately resistant; S = susceptible; MS = moderately susceptible. [c]BLS = bacterial leaf streak; B = blast; T = tungro; BPH = brown planthopper; GLH = green leafhopper; SB = stem borer; GM = gall midge. [d]Inheritance to typical Philippine strain of *X. oryzae* (Pxo 61).

Table 16. Sources of resistance to bacterial leaf streak from tall indica varieties and their semidwarf progenies.[a]

Variety or cross	Resistance		Comments
	India	Philippines	
		Talls	
BJ 1	MR	R	R-MR to BB
DZ 192	–	MR	R-MR to BB
Zenith	MR-MS	MR	R-MR to B and BB
Perurutong (NB)	–	MR	MR to BB
TKM 6	MR	MR	R to BB
		Semidwarfs	
Vijaya	MR	R	High yield potential
RP 291	MR	MR	
IR 1545	–	R	R to BB
IR883	–	MR	Pure line
IR127-80-1	–	R	R to BB, T; pure line
IR26	–	MR	R to BB, T, BPH, GLH

[a]Source: Ou *et al.* 1971; Row *et al.* 1968 Rao *et al.* 1972.

hybrid lines – have been developed. Progenies from some crosses between resistant varieties have broader spectrum and higher levels of resistance than the individual parents.

Good sources of resistance to bacterial leaf streak and resistant hybrid lines are shown in Table 16. The following tall local varieties and hybrid lines are resistant to tungro virus.

Adday local (Sel)
Adday (Sel)
Andi from N. Pokhara
T412
Basmati 37
Basmati 370
Bengawan
Chunta 313 Hao x
Binastian
Dee-geo-mean-don

Pehkahok-kimkan
Prine Chan Ying Tao
PI 160677-2
PI 184675-2
PI 184675-4
PI 184676
Podiwi, A8
Rajamandal Baran
Ram Tulasi
Red Rice

Table 17. Sources of resistance to tungro virus: tall donor parents and their semidwarf progenies.

Tall resistant donor	Semidwarf progenies	Cross[a]	Resistance to other diseases and insects
Gam Pai	IR2061-464	IR833//IR1561/IR1737	BB, GSV, BPH, GLH
	XB-Z	Gam Pai 15^2/TN1	
H8	BG11-11	Engkatek/H8//H8	BPH, GLH
HR21	IR1364-37	IR262/HR21	GLH
Pankhari 203	IR825-11-2	(IR8/P203//Peta^6/TN1)	–
Peta	C4-63	BPI 76/Peta	GLH
PTB 18	CR94-13	PTB 18/PTB 21//IR8	BPH, GLH, GM
	IR2070 selections	IR20^2/*O. nivara*//CR94-13	BB, GSV, BPH, GLH
	IR2071 selection	IR1561/IR1737///CR94-13	BB, GSV, BPH, GLH
Sigadis	Mala	CP-SLO^2/Sigadis	BB, GLH
TKM 6	IR20	IR262/TKM 6	BB, GLH, SB
	IdZ6	IR24/TKM 6	BB, BPH, GLH, SB
W1263	IR2039 selections	IR1330-5/IR1737	BB, GSV, BPH, GLH, GM

[a] / = first cross; // = second cross; /// = third cross.

DV 29
Fadjar
FB 24
Habigonj DW # 8
H4
Indrasail
JC 170
Kai Lianh Hsung Tieng
Ladang
Lang Chung Yi Lung Ju
Latisail (Dacca 17)
Latisail (T. Aman)
Malagkit Sungsong
Padi Kasalle
Salak 2885
Seratus Hari T/36
Seri-Raja
Tjahaja
Tjeremas
TP x Rexoro SB
Tsou-yuen
Urang-urangan 89
59-334 (B-11 x Mass)
6517

We also find sources of resistance to tungro among tall varieties and their semidwarf progenies (Table 17).

The only source of high-level resistance to grassy stunt is a strain of wild rice, ***Oryza nivara.*** Fortunately, the resistant gene of this strain is easily transferred to many semidwarf varieties. Several sources of field resistance to grassy stunt without ***Oryza nivara*** heritage appear promising, particularly **CR94-13** from India. Many hybrid lines that are resistant to both the viruses and their vectors are now being tested.

Distinct genetic differences in resistance to sheath blight have been observed, although highly resistant **or** immune varieties have not been found. The upland variety Hashikalmi and the dual-purpose variety Dular are both moderately resistant. Most of the following varieties and hybrid selections are lowland rices that appear to be at least moderately resistant to sheath blight:

Tall	Dwarfs
CTG 1206	Bahagia
DD 24	Mehran
DD 63	Pankaj
Dular	Pelita 1/1
DZ 192	
Hashikalmi	
Kunrari DA-15	
K.P.F. 6	
Laka	
TKM 6	
46 Palman	

Because several diseases often occur simultaneously in the same field, new upland varieties should have combined resistance to all major diseases. Several promising hybrid lines developed for lowland culture have such resistance. Although IR26 is resistant or tolerant to most rice diseases, neither it nor other promising hybrids have been tested for suitability for upland culture.