Classification of *Xanthomonas Oryzae* (Uyeda et Ishiyama) Dowson by Means of Differential Rice Varieties in Japan

By AKINORI EZUKA

Division to Plant Pathology, Department of Plant Pathology and Entomology, National Institute of Agricultural Sciences

In 1957 "Asakaze", a rice variety bred for the resistance to bacterial leaf blight (*Xanthomonas oryzae* (Uyeda et Ishiyama) Dowson), was unexpectedly attacked by this disease in Fukuoka Prefecture, Japan.

Kuhara et al.[6] reported that it was due to "breakdown" of the resistance induced by a new strain of *X. oryzae*. This was the first chance for Japanese breeders and plant pathologists to realize the importance of host-pathogen relationship in this disease.

Since then, a number of studies have been made by many investigators to classify varieties by their resistance to bacterial strains, as well as to classify bacterial strains by their pathogenicity to rice varieties.

The classification systems proposed by those investigators were not always the same, but were much different especially in the designation of the groups of rice varieties and bacterial strains. Unnecessary confusion was consequently introduced into the literature of bacterial leaf blight so far published in Japan.

Comparison of different classification systems

Table 1 shows the comparison of different classification systems proposed by the leading investigators. Although the same varietal or bacterial groups were often named different by different investigators, those differences

Table 1. Comparison of different classification systems of rice varieties and *Xanthomonas oryzae* strains so far proposed in Japan (Ezuka & Horino[1])

Classification of	Kariya & Washio (1959)	Yoshimura et al. (1960)	Kuhara et al. (1965)	Kusaba et al. (1966)	Sakaguchi et al. (1968)	Washio et al. (1966)	Kozaka (1969)
Rice varieties	Asahi etc.	Suscept. vars.	Suscept. vars. / Mod. res. vars.	Suscept. vars.	Kinmaze group	Group IV	Kinmaze group
	Kogyoku etc.	Resist. vars.	Resist. vars.	Resist. vars.	Kogyoku group	Group III	Kogyoku group
	—	—	—	—	Rantaj-emas	Group II	Rantaj-emas group
	—	—	—	—	—	Group I	Wase Aikoku group
Bacterial strains	H-9	Less virul. strains	Group II	Group B	Group I	Group A	Group I
	H-15, H-16	Highly virul. strains	Group I	Group A	Group II	Group B	Group II
					Group III	Group C	Group III

Table 2. Differential reactions between rice varieties and *Xanthomonas oryzae* strains from Japan (Kozaka[5])

Varietal group	Representative variety	Reaction* to bacterial group		
		I	II	III
Kinmaze group	Kinmaze, Jukkoku, Norin 37, Shimotsuki, Asahi, Originario	S	S	S
Kogyoku group	Kogyoku**, Zensho 17, Norin 27, Nep-Vai, Daiyoshi, Sigadagabo	R	S	S
Rantaj-emas group	Rantaj-emas 2, Tadukan, Te-tep, Nigeria 5	R	R	S
Wase Aikoku group	Wase Aikoku 3**, Nakashin 120, TKM-6, Lead Rice	R	R	R

* S: Susceptible, R: Resistant.
** Occasionally Kogyoku is called "Kidama," and Wase Aikoku 3 is called "Aikoku-soto-sango-kei," by some investigators.

are not so essential from the viewpoint of differential interactions between host and pathogen.

Ezuka and Horino[1] employed Kozaka's system[5] in their studies to classify rice varieties and bacterial isolates because they considered it to be most appropriate for the occasion.

According to Kozaka's system, strains of *X. oryzae* from Japan are divided into three groups (pathotypes), I, II, and III, while rice varieties including native and bred *japonicas* and some *indicas* are divided into four groups (pathodemes), Kinmaze group, Kogyoku group, Rantaj-emas group, and Wase Aikoku group, on the basis of their differential interactions as shown in Table 2. It may be said that this classification system has been accepted by most of the Japanese plant pathologists working on *X. oryzae*.

Classification of rice varieties and bacterial isolates

Ezuka and Horino[1] tested 149 rice varieties from various origins for the resistance to three pathotypes of *X. oryzae* and divided them into four varietal groups as shown in Table 3. The great majority of *japonica* paddy varieties were classed as Kinmaze group, while some of them bred for the resistance to *X. oryzae* were classed as Kogyoku group. Rantaj-emas group and Wase Aikoku group did not include any Japanese leading varieties.

Sakaguchi[7] reported the resistance of the Kogyoku group to be governed by a dominant resistance gene, *Xa-1*, and that of the Rantaj-emas group to be governed by two or three dominant genes including *Xa-1* and *Xa-2*.

The resistance of some varieties belonging to the Wase Aikoku group was demonstrated by Ezuka et al.[4] to be governed by a dominant resistance gene, *Xa-w*, which is operative to

Table 3. Relation between plant type of rice varieties and the grouping of their resistance to *Xanthomonas oryzae* (Ezuka & Horino[12])

Plant type	Number of varieties for			
	Kinmaze group	Kogyoku group	Rantaj-emas group	Wase Aikoku group
Japonica paddy	83	18	4	10
Japonica upland	2	0	1	0
Indica or intermediate	7	4	11	9
Total	92	22	16	19

three bacterial pathotypes in Japan.

Ezuka and Horino[1] further tested 120 isolates of *X. oryzae* collected from the Tokai-Kinki region, the central part of Japan, for the pathogenicity to three differential rice varieties, Kinmaze, Kogyoku, and Te-tep (Rantaj-emas group), and divided the isolates into three pathotypes as shown in Table 4.

Table 4. Summarized result of the survey of pathotype of *Xanthomonas oryzae* isolates collected from Tokai-Kinki region during 1970–1971 (Ezuka & Horino[1])

Prefecture	Number of bacterial isolates belonging to each pathotype		
	I	II	III
Shizuoka	14	4	0
Aichi	7	1	5
Gifu	15	7	0
Mie	13	5	1
Shiga	22	1	0
Kyoto	18	0	1
Osaka	1	3	0
Wakayama	1	0	1
Total	91	21	8

Most part of the isolates were classed as group I, while some of them were classed as group II or III. No isolate was found clearly pathogenic to Chugoku 45, a variety bred from Wase Aikoku 3 possessing *Xa-w*. These facts suggest the importance of breeding resistant varieties belonging to the Wase Aikoku group under the present conditions in Japan.

Future problems

It is noticeable that most of the reports from tropical Asia do not support the existence of so clear-cut differential interaction between rice varieties and bacterial isolates as demonstrated in Japan.

Ezuka and Horino[3] suggested that this may be attributed in part to the lack of vertical resistance in the tested combinations of varieties and bacterial isolates, and in part to the incomplete expression of vertical resistance owing to the young age of rice plants used for the inoculation.

Ezuka et al.[2] reported that the resistance of some varieties of the Wase Aikoku group often appeared nearly susceptible when too young seedlings were inoculated with highly aggressive isolates by the needle prick method.

It is also quite probable that the gene constitution of resistance and pathogenicity may be far more complex in the tropics than in Japan.

Careful studies will be needed on the question whether the differential system established in Japan is valid or not in the tropics.

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