Identification of Pathogenic Races of Pyricularia oryzae in India

S. Y. Padmanabhan, N. K. Chakrabarti, S. C. Mathur, and J. Veeraraghavan

Director, Mycologist, and Plant Pathologists, respectively, Central Rice Research Institute, Cuttack, India.
Aided by funds from the USDA under PL-480. The authors are grateful for their help.
Accepted for publication 1 June 1970.

ABSTRACT

One hundred thirty-two isolates of *Pyricularia oryzae* obtained from blast-infected rice samples from the principal rice-growing states of India were tested on the international set of eight differential rice cultivars. Thirty-one races of the fungus were determined, 21 of which were new. The races belong to the international race groups IA, IC, ID, IE, IF, and a new race group designated as IJ. All the eight differentials were resistant or moderately resistant to this isolate, but other cultivars, including Yakeiko and Aichi-Asahi, were susceptible. The most prevalent races in India were IC 3 and ID 1. The cultivars Zenith, Te-tep, and Tadukan were resistant to all races so far identified in India.
Phytopathology 60:1574-1577.

The occurrence of pathogenic races of *Pyricularia oryzae* Cav., the fungus causing blast disease of rice, was first reported from India by Padmanabhan (10) in 1965. Progress in identification of races in India up to 1966 was reported by Chakrabarti et al. (1) and Padmanabhan et al. (11). This report presents the latest information in the identification and distribution of races of *P. oryzae* in India.

MATERIALS AND METHODS.—The procedures used have been described in detail earlier (11) and are mentioned briefly below.

The international set of eight differential cultivars, viz, Raminad Str. 3, Zenith, NP 125, Usen, Dular, Kanto 51, C.I. 8970-S, and Caloro proposed by the United States-Japan Cooperative Blast Project was used. Four cultivars from Lattrell et al.'s set of differentials (7), viz, Wag Wag, C.I. 5309, C.I. 8970 (P), and Lacrosse, two Japanese differentials, Te-tep and Tadukan, and three Indian differentials, BJ 1, S 67, and Co. 13, were also included to obtain additional information.

Isolations were made from samples of diseased leaves, necks, and nodes of infected rice plants collected from the principal rice-growing regions of India on oatmeal agar (OMA) with traces of biotin and thiamine (B & T). Cultures were purified by dilution method, and single-spore isolates were grown and multiplied on OMA + B & T at 25 C. Stock cultures were maintained on sterilized host nodes at 5 C.

Spore suspensions for inoculation were prepared from 12- to 15-day-old cultures having at least 6 to 8 spores/microscopic field under low power magnification. In case of weakly sporulating isolates, the entire thallus was removed from OMA and homogenized with water in a Waring Blendor for inoculation.

Seedlings of the differentials were grown in nursery boxes with partitions containing 20 kg field soil mixed with 10 kg compost and 15 g superphosphate. Ammonium sulphate was applied in two doses of 15 g each, at sowing and 1 week before inoculation.

The inoculation chambers were made of wooden frames of 1.5 m × 1 m × 1 m with a glass door in front, glass behind, and muslin cloth on the sides and top. The front door was provided with additional cloth curtains.

Three-week-old seedlings of differentials were kept in inoculation chambers. Inoculations were carried out late in the evening when temp fell below 26 C (mostly during September to March). To maintain high relative humidity, cloth curtains of the inoculation chambers were kept wet overnight with the help of running water to maintain high relative humidity.

The following reaction types were used to score infection as described by Padmanabhan & Ganguly (12): A, reddish flecks only; B, minute reddish spots showing no differentiation into distinct zones; C, circular spots about 2 to 3 mm in diam with a central ashy zone and a purplish brown margin; D, broadly spindle-shaped spots only slightly longer than broad, 3-5 mm in diam; E, large, distinct spindle-shaped spots with a central ashy zone and marginal zones 3 to 5 mm broad and up to several cm in length.

Though the cultivars were classified as resistant (R) with A and B scores, moderately resistant (MR) with C, and susceptible (S) with D and E, only two reactions, R (R and MR) and S, were used for race identification.

One hundred and thirty-two isolates of *P. oryzae* obtained from the different states of India were tested.

RESULTS.—*Race reactions.*—On the basis of the reaction of the eight international differentials, 31 races of *P. oryzae* were identified (Table 1). These races conform to the international race groups IA, IC, ID, IE, IF, and a proposed new race group, IJ, characterized by resistant reaction of all eight international differentials. Isolates belonging to race groups IB, IG, and IH have not been detected thus far in India.

Of the 31 races identified, only 10 have been reported earlier (13); the new races have been assigned numbers 4 to 11 in group IA, 6 to 8 in IC, 12 in ID, 3 and 4 in IE, 3-8 in IF, and 1 in IJ. The number of isolates falling in race groups IA, IC, ID, IE, IF, and IJ were 30, 49, 22, 8, and 1, respectively. The most common race was IC 3, with 31 isolates, followed by ID 1, IE 1, and IC 1.

Of the four USA differentials tested, C.I. 5309 and C.I. 8970 (P) were susceptible to all races of *P. oryzae*. Clear-cut differentiation between S and R reactions could not be observed on Lacrosse, whereas Wag Wag gave good differential reaction to the isolates tested. The Japanese differentials Te-tep and Tadukan were resistant to all races. The Indian variety Co. 13 was

TABLE 1. Reaction of international rice differentials to pathogenic races of *Pyricularia oryzae* in India

International race group	International race	Reaction per differential variety[a]								No. isolates	Prior race	
		Raminad Str. 3	Zenith	NP 125	Usen	Dular	Kanto 51	C.I. 8970 (S)	Caloro		USA	Japan
IA	1	S	R	R	S	S	S	S	S	3		
	4*	S	R	R	R	S	S	S	S	5		
	5*	S	R	R	S	S	R	S	S	1		
	6*	S	R	S	S	S	S	S	S	3	25	
	7*	S	R	R	R	S	S	S	R	2		
	8*	S	R	R	R	S	S	R	R	1		
	9*	S	R	R		R	S	S	R	1		
	10*	S	R	R	R	R	S	S	S	1		
	11*	S	R	S	R	S	S	S	S	13	25	
IC	1	R	R	S	S	S	S	S	S	12	9	T-1
	3	R	R	S	R	S	S	S	S	31	16, 22	
	4	R	R	S	R	S	S	R	S	1		
	6*	R	R	S	R	S	S	S	R	3		
	7*	R	R	S		S	S	R	R	1		
	8*	R	R	S	R	S	R	R	R	1		
ID	1	R	R	R	S	S	S	S	S	19	8, 19	
	3	R	R	R	S	S	R	S	S	1		
	10	R	R	R	S	R	R	R	S	1	4	T-2
	12*	R	R	R	S	S	S	S	R	1		
IE	1	R	R	R	R	S	S	S	S	13	8	C-1, C-2, C-4, C-5, C-6
	2	R	R	R	R	S	S	R	S	1		C-8
	3*	R	R	R	R	S	R	S	R	1		
	4*	R	R	R	R	S	S	R	R	3		
	5*	R	R	R	R	S	S	S	R	1		
	6*	R	R	R	R	S	R	S	S	1		
	7*	R	R	R	R	S	S	S	R	1		
	8*	R	R	R	R	S	R	R	R	1		
IF	1	R	R	R	R	R	S	S	S	5		C-1
	3*	R	R	R	R	R	S	S	R	2		
	4*	R	R	R	R	R	S	R	R	1		
IJ	1*	R	R	R	R	R	R	R	R	1	10	

[a] R = resistant; S = susceptible; * = new races.

susceptible to all races, but BJ 1 and S 67 gave differential reactions.

Race distribution.—The geographical distribution of 31 races in India is given in Table 2.

DISCUSSION.—The eight international differentials were not sufficient to characterize the range of pathogenicity found amongst Indian isolates of *P. oryzae*. An isolate from Assam was not pathogenic on the eight international differentials but induced typical blast lesions on other cultivars included in the test, viz, Yakeiko and Aichi Asahi.

The cultivars Dular from India and Kanto-51 from Japan were susceptible to most of the Indian races, and therefore were of little value as differentials. On the other hand, the cultivars NP 125 from India, C.I. 8970 (S), and Caloro from the USA, Raminad Str. 3 from The Philippines, and Usen from Japan were useful differentials for the Indian isolates used.

We suggest that besides Zenith, which is susceptible to 6 races of the IB group in the USA, Japan, Costa Rica, El Salvador, Guinea, and Colombia (2, 13), either Te-tep or Tadukan be used as a subsidiary differential to identify new races in India, since Te-tep is susceptible to race T 1 (Kan 53-33) of Japan (*personal communication*) and Tadukan to seven races J 4 to J 10 of The Philippines (5). Similarly, Co. 13, which was susceptible to all isolates used in this study, should be retained for race identification, firstly to estimate the success of infection, and secondly to identify the occurrence of a new race to which Co. 13 may be resistant.

United States and Japanese workers (13) working with Indian isolates identified races IA 1, IC 1, IC 3, ID 1, ID 2, ID 4, ID 6, IE 1, and IG 1. Of these, only race IG 1 was not encountered in the present study.

Five of the races identified in the present study, IC 3, ID 1, IE 1, ID 10, and IJ 1, occur in the USA. These correspond to four USA races, 16, 8 (ID 1 and IE 1), 4, and 10 respectively. Race IG 1 identified by United States and Japanese workers (13) from Indian isolates corresponds to USA race 3. Races IA 6 and IA 11 (= USA race 25), IC 1 (= USA 9), IC 4 (= USA 20), and IE 2 (= USA 23) were also identified. These were differentiated by Latterell et al. (6) from samples received from outside the USA. Races common to India and Japan (IC 1, ID 10, IE 1, IE 2, and IF 1) fall under Japanese race groups T and C.

Races IA 11, IC 3, ID 1, and IE 1 were prevalent in all regions of India (Table 2). On the other hand, some appear to be restricted to particular regions.

TABLE 2. Geographical distribution of races of *Pyricularia oryzae* in India

Region	States	International race groups and races					
		IA	IC	ID	IE	IF	IJ
				Race no.			
Eastern Region	Assam	6		1		3	1
	Tripura			1			
	West Bengal	10, 11	1, 3	1, 10	4, 8	1	
	Bihar	1, 8	1	1			
	Orissa	1, 4, 6, 9, 11	1, 3, 6	1	1, 4	1	
Northern Region	Jammu & Kashmir			1			
	Himachal Pradesh	5	3, 8		1		
	Uttar Pradesh	4, 6, 11	3	1	1		
	Madhya Pradesh	11					
Western Region	Gujerat	11	3	1		4	
	Maharashtra	4, 11	1, 3	1	1, 3, 5		
Southern Region	Andhra Pradesh	11	1, 3	1	2, 4, 7		
	Madras	7	4, 6	1, 3		3	
	Mysore	7, 11	1, 3, 7	1, 12	1		
	Kerala	1, 11	1		6		

More races common amongst the different regions of India may, however, be found when large number of isolates are secured and tested.

Since United States and Japanese workers (13) reported 31 races based on the reaction of the international differentials, additional races have been identified in India and elsewhere and have been assigned new numbers arbitrarily. Recently, Galvez-E and Lozano-T (2) have also reported nine new races from Colombia and assigned designation used elsewhere, though the races are not the same. If this procedure is continued it is clear that much confusion will result. Based on the reaction of eight differentials, it is possible to designate pathogenicity patterns of all the possible 256 races of *P. oryzae*. A suggestion made in this regard by the senior author has been generally accepted (8).

In this study, we observed that when the same isolate was retested, either in the same season or in another season (October-December and February-March), the reaction in some cases differed from the original reaction (R to M or M to R and, rarely, M to S or S to M). This might be due either to the variability of the isolates or to the variability of host reaction under different conditions of growth. Similar observations have been made by Goto et al. (4) with Japanese isolates. The instability of isolates hinders the identification of races as well as studies on inheritance of resistance. As suggested by Goto et al. (4), the identification of races must be done within 3 to 4 months after isolation, and only the isolates which prove stable throughout this period should be considered as legitimate races of *P. oryzae*. The report by Ou & Ayad (9) that 10 races could be isolated from a single lesion, and the six races reisolated from 25 monoconidial subcultures of two isolates, is an interesting finding. Giatgong & Frederiksen (3) also observed different disease patterns on a set of differentials with the monoconidial lines of three successive generations of two races of *P. oryzae*, presumably due to genetic changes within the pathogen. They suggested that identification of pathogenic races should be based on several monoconidial subcultures originating from single-spore isolates instead of a single-spore isolate alone. Standardization of the technique with regard to min numbers of monoconidial subcultures to be tested etc. is needed.

LITERATURE CITED

1. CHAKRABARTI, N. K., S. C. MATHUR, J. VEERARAGHAVAN, & S. Y. PADMANABHAN. 1966. The present position of physiologic races of Piricularia oryzae Cav. in India. Indian Phytopathol. Soc., Bull. 3: 102-109.
2. GALVEZ-E, G. E., & J. C. LOZANO-T. 1968. Identification of races of Piricularia oryzae in Colombia. Phytopathology 58:294-296.
3. GIATGONG, PIYA, & R. A. FREDERIKSEN. 1969. Pathogenic variability and cytology of monoconidial subcultures of Piricularia oryzae. Phytopathology 59: 1152-1157.
4. GOTO, K., et al. 1964. Summary of special rep. on dis. and insect forecasting, No. 18, Plant Protection Sect., Bur. Agr. Adm. Ministry of Agr. Forest., Tokyo, Japan.
5. INTERNATIONAL RICE RESEARCH INSTITUTE, Los Banos, Laguna, The Philippines. 1964. Annu. Rep. p. 133.
6. LATTERELL FRANCES M., M. A. MARCHETTI, & B. R. GROVE. 1965. Co-ordination of effort to establish an international system for race identification in Piricularia oryzae, p. 257-274. In Rice Blast Symp. Proc. Int. Rice Res. Inst., Johns Hopkins Press, Baltimore.
7. LATTERELL FRANCES M., E. C. TULLIS, & J. W. COLLIER. 1960. Physiologic races of Piricularia oryzae Cav. Plant Dis. Reptr. 44:679-683.
8. LING, K. C., & S. H. OU. 1969. Standardization of the international race numbers of *Pyricularia oryzae*. Phytopathology 59:339-342.
9. OU, S. H., & M. R. AYAD. 1968. Pathogenic races of Pyricularia oryzae originating from single lesions and monoconidial cultures. Phytopathology 58:179-182.

10. PADMANABHAN, S. Y. 1965. Physiologic specialization of Piricularia oryzae Cav., the causal organism of blast disease of rice. Curr. Sci. 34:307-308.
11. PADMANABHAN, S. Y., N. K. CHAKRABARTI, S. C. MATHUR, & J. VEERARAGHAVAN. 1967. Physiologic specialization in Piricularia oryzae Cav. Indian Acad. Sci. Proc. Sect. B.66:63-73.
12. PADMANABHAN, S. Y., & D. GANGULY. 1959. Breeding rice varieties resistant to blast disease caused by *Piricularia oryzae* Cav. I. Selection of resistant varieties from genetic stock. Indian Acad. Sci. Sect. Proc. B.50:289-304.
13. UNITED STATES AND JAPAN COOPERATIVE STUDY. 1967. An international set of rice varieties for differentiating races of Piricularia oryzae. Phytopathology 57: 297-301.