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Specialisation in Pathogenicity of *Pyricularia oryzae* Cav.

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Literature on specialisation in the pathogenicity of *Pyricularia oryzae* Cav. has been reviewed. The use of the term "pathogenic race" to refer to pathotypes in *P. oryzae* has been elucidated. Stability in pathogenicity of *P. oryzae* has been discussed in relation to method of distinguishing pathotypes of the pathogen utilising reactions of the host. The need for maintaining one check for inoculation with a standard culture of the pathogen to monitor the genetic purity of the differential along with another check to monitor natural infection has been stressed. The need for certifying that only the incitant alone has caused the symptom has been emphasized. Reports of pathotypes in *P. oryzae* would derive validity only when the accession numbers of the differential hosts and their source are mentioned in any communication along with the registration number of the standard reference culture of the pathogen in a standard type culture collection.

Key Words: Specialisation, Pathogenicity, *Pyricularia oryzae*, Race differential

Introduction

The extent of specialisation in the pathogenicity of a plant pathogen is assessed by utilising the effect it brings about in the plants which resist it or entertain it. Does physiologic specialisation in a plant pathogen represent the host-range or the level of pathogenicity? An understanding of this term is essential before delving into the problem of specialisation in the pathogenicity of a pathogen. A pathotype (pathogenic race) refers to culture(s) of a pathogen with a specific host-range of cultivars of a species as reflected by literature. If it refers to levels of pathogenicity it could be classified as highly virulent and less virulent. To assess the level of pathogenicity, one resistant and one susceptible variety of the host are adequate. Biological entities with the same host-range are being grouped into physiologic races of the pathogen at present. Physiologic race denotes group of forms like in morphology but unlike in certain cultural, physiological, biochemical, pathological or other characters (Ainsworth & Bisby 1945). Stakman and Harrar (1957) described physiologic race in a pathogen as a biotype or groups of biotypes within a species or variety that can be distinguished with reasonable certainty and facility by physiological characters including pathogenicity and

in some fungi by growth characters on artificial media. If a culture of a pathogen is found to change its pathogenicity it cannot be designated as a physiologic race/pathogenic race.

Latterell et al. (1954) reported the existence of physiologic specialisation in *P. oryzae* in USA utilising the reaction of certain varieties of *Oryza sativa* L. Sasakii (1922) attributed the different reactions of certain varieties of rice to *P. oryzae* to the existence of specialisation in Japan.

Latterell et al. (1960) reported the detection of physiologic races in *P. oryzae* in several countries of the world utilizing two categories of host-reaction i.e., resistance and susceptibility employing 10 rice varieties termed "United States Blast Differentials (USBD)".

Atkins (1962) adopted the term "pathogenic race" to refer to culture(s) of *P. oryzae*, incitant of blast disease of rice, which differ in their pathogenicity on specific varieties of the host chosen for the purpose and designated as 'differentials', while Latterell et al. (1965) referred it "to denote strains of an organism that differ in their ability to attack certain varieties of a single species of host plant".

Differentials

Latterell et al. (1965) reported the occurrence of pathogenic races in several countries of the world utilizing three categories of host reaction i.e., resistance, moderate and susceptibility. Atkins et al. (1965, 1967) reported the occurrence of pathogenic races of *P. oryzae* in Western Hemisphere certain other countries adopting the above three categories. However the results revealed that resistance and susceptibility were encountered. They utilised 8 rice varieties, designated as International Blast Differentials (consequent to a collaborative study between Japan and the USA), namely Raminad Str. 3 (PI 231128), Zenith (CI 7787), NP-125 (PI 201902), Usen (PI 280583), Dular (PI 180061), Kanto-51 (PI 280578), Sha-tiao-tsao [CI 8970(S)] and Caloro (CI 1561-1). They emphasized that the seeds should be obtained from any one source only to avoid differences in the genotype of the differentials between one test and another. Atkins et al. (1967), did not specify the incubation period for recording observation consequent to inoculation with the pathogen. However 10 days are usually considered enough for the purpose.

Atkins et al. (1967) method for distinguishing pathogenic races in *P. oryzae*, has since been adopted by many countries. They had grouped the pathogenicity-patterns on the 8 differential varieties of rice into 8 groups designated as IA, IB, IC, ID, IE, IF, IG and IH taking into consideration the susceptibility of a key differential.

Ling and Ou (1969) accommodated 256 pathogenicity patterns which are likely to be obtained utilising eight differentials and two reactions i.e., resistance and susceptibility, into nine groups. The cultures of *P. oryzae* which produced a susceptible reaction on Raminad Str. 3 were accommodated under IA group (128 patterns). The cultures which produced a susceptible reaction on the second differential Zenith, while Raminad Str. 3 proved resistant, were grouped as IB group (64 patterns). The cultures with susceptible reaction on NP-125 but causing resistance in Raminad Str. 3 and Zenith were designated as IC group (32 patterns). Similarly, the cultures causing susceptibility in Usen/Dular/Kanto-51/CI 8970(S) or Caloro but resistance in the previous differentials taken in a sequential order, were designated as ID, IE, IF, IG, IH groups with 16, 8, 4, 2, 1 pathogenicity-patterns respectively. The race group II was proposed to represent cultures which might produce a resistant reaction on all the differentials.

They suggested that when a culture produced a moderate reaction on a differential, the designation of the race would be that of the one which represents resistant reaction of that differential with the English alphabet in the small case taken sequentially to indicate which one of the eight differentials gave the moderate reaction as a, b, c, d, e, f, g, h, e.g., IC. 17a.

Veeraraghavan (1975b) accommodated 256 possible pathogenicity-patterns on 8 differentials utilising resistance and susceptibility as reactions of the host into 16 groups designated serially, as A to P. The first 8 groups (A–H) were based on the susceptible reaction of the differentials while the rest (I–P) were based on the resistant reaction. The arabic numerals were utilised to indicate the designation of the pathotype. Thus, the pathogenic race IC-3 (Atkins et al. 1967) will be the same as IC-17 (Ling & Ou 1969) or O-17 (Veeraraghavan 1975b).

Gilmour (1973) presented designation of pathogenicity-patterns utilising three sets of three varieties of the host, each utilising numbers to designate pathogenicity-patterns of plant pathogens.

Different countries continued to adopt their own differential varieties to group cultures of *P. oryzae* into pathogenic races while designating the pathogen as Philippine races, Japanese races, Indian races, etc.

Investigators in USA utilised international blast differentials although they had earlier utilised 10 US differentials. Japan utilised 12 differentials (Goto et al. 1964). Yamada et al. (1976) employed nine varieties of *O. sativa* to identify pathogenic races in *P. oryzae*. Kiyosawa (1976) adopted 13 rice varieties as differentials to group cultures of *P. oryzae* into pathogenic races.

Investigators in Korea, Taiwan, Philippines and Colombia utilised 10, 16, 12 and 10 differential varieties of *Oryza sativa* respectively, for identifying pathotypes in *P. oryzae* (Ahn & Chung 1962, Chiu et al. 1965, Bandong & Ou 1966, Galvez & Lozano 1968). Veeraraghavan and Premalatha Dath (1981)

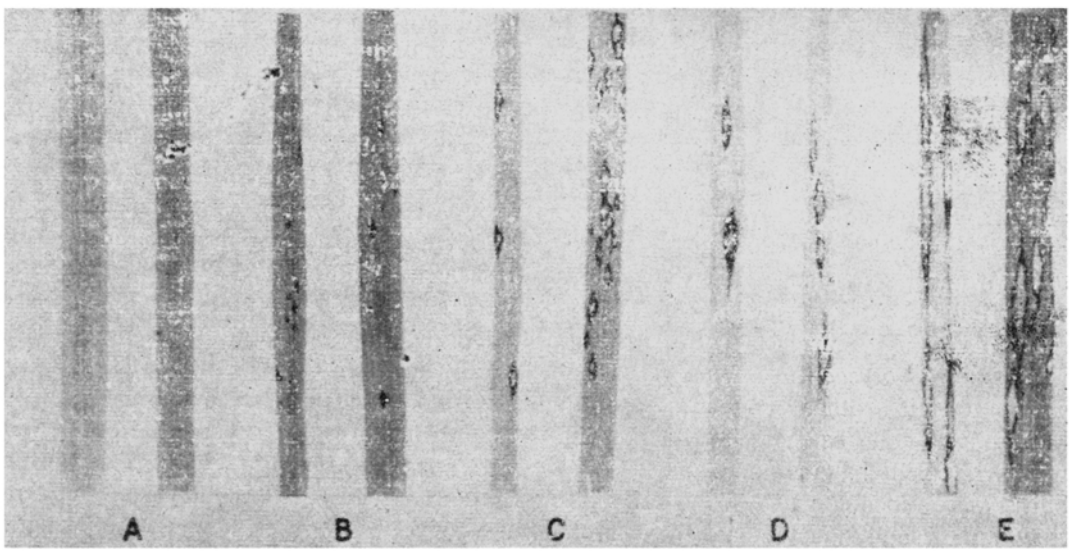

Figure 1 Lesion types of Blast Disease

utilised 8 varieties of rice i.e., P.I. 280602, P.I 380001, C.I 7787, P.I 372279, P.I 180061, P.I 201902, C.I 8970(S) and P.I 403392, i.e. Te-tep, Tadukan, Zenith, Carreon, Dular, NP-125, Sha-tiao-tsao(S) and C0.13 as *P. oryzae* differentials. The plants were raised from single seed and maintained by vegetative propagation during the period of investigation utilising tillers.

Number of Host Reactions

Only two types of reaction of the host i.e., resistance and susceptibility are considered currently for the identification of pathotypes in *P. oryzae* (Padmanabhan et al. 1970, Latterell 1975, Marchetti et al. 1976, Yamada et al. 1976, Premalatha Dath & Veeraraghavan 1977, Veeraraghavan & Premalatha Dath 1981).

Criterion for distinguishing Reaction Types

Occurrence of pathogenic races in *P. oryzae* was reported by Goto et al. (1964) and Matsumoto et al. (1969) utilising three categories of host-reaction i.e., resistance, moderate and susceptibility, utilising 12 varieties of differentials. Roundish lesions with ashy grey centre with brown margin which was limited to interveinal space were considered as moderate reaction synonymous to type '3' lesion—elongated roundish—as per Standard Evaluation System Score Chart (IRRI 1980) or type '3' and '4' lesions of Atkins et al. (1967) or type 'C' lesion as per Padmanabhan et al. (1967) or moderate reaction (Ou 1972) or moderate reaction type '3' imponderables (Latterell 1975).

Yamada et al. (1976) recognised two categories of host reaction, i.e. resistance and susceptibility. They did not communicate the position of moderate reaction as per Goto et al. (1964) i.e. type '3' lesion as per SE System Score chart of IRRI (1980) as to whether they were not taken into consideration or whether they were deemed as resistance/susceptibility.

Bandong and Ou (1966) considered roundish lesions with brown margin and ashy grey centre to represent resistance of the differential for the purpose of classifying pathotypes of *P. oryzae*.

Padmanabhan et al. (1967, 1970) deemed round lesions with purplish brown borders and ashy grey centre type 3 of Standard Evaluation System Chart of IRRI as resistant reaction of the differential for identification of pathogenic races of *P. oryzae*. Atkins et al. (1967) suggested restricted lesions with greyish centres and brown margin as moderate. According to them well developed necrotic lesions without restricted margins were susceptibility symptoms. The moderate reaction (3 & 4) of Atkins et al. (1967) corresponds to type 'C' of Padmanabhan et al.(1967); and Intermediate of Goto et al. (1964). (Fig.)

Latterell et al. (1960) considered roundish eye spots with ashy grey centre and brown margin as resistant reaction of the differential and more elongated ones as susceptible for classifying pathogenic races of *P. oryzae*. Latterell et al. (1965) stated that clear-cut difference between resistant and susceptible reaction type 2 and 4 as per IRRI system of at least one differential is essential for recognition of pathotypes of *P. oryzae*.

Veeraraghavan and Premalatha Dath (1975) suggested that round lesions with ashy grey centre and brown margin —'C' type as per Padmanabhan et al. (1967) —should be deemed as susceptible reaction of the differential for distinguishing pathogenic races in *P. oryzae* since both 'C' (circular) and 'D' type (elongated) lesions possessed ashy grey centre and brown margin and lesions which fall between 'C' and 'D' types could occur, which would present difficulty in classifying reaction of the cultivar. There should be no scope for confusion or ambiguity in distinguishing resistant reaction of the differential from susceptibility.

The type of lesion which one scores as '3' type lesion as per Standard Evaluation Chart of IRRI is likely to be considered as '4' type lesion as per the same chart by another investigator since the difference between '3' and '4' is too meagre: elongated roundish or elliptical. These two types of lesions are equivalent to type 'C' and 'D' lesions (Padmanabhan et al. 1967). Both have ashy grey centre and brown margin. There is a slight difference in shape between them. Identification of pathogenic races in *P. oryzae* with '3' (IRRI score chart) elongated roundish lesions with ashy grey centre and brown margin as resistant or moderate reaction would result in error in judgement of the reaction leading to apparent pathogenicity-patterns being reported as representing different pathotypes. Besides, two overlapping lesions '3' (IRRI score chart) could present the appearance of score '4' —elliptical—of that chart. Lesions which fall between score '3' and '4' could be designated either as that of a culture of one pathogenic race or as of another.

For the purpose of distinguishing pathotypes in *P. oryzae*, the distinction between resistance and susceptibility of the differential has to be clear-cut.

None of the investigators who have utilised 'C' type lesion (Padmanabhan et al. 1967) or '3' SES (IRRI) as resistant moderate for separating pathotypes have certified that 'C' and 'D' type lesion or '4' SES (IRRI) yielded *P. oryzae* only, although *P. oryzae* was employed for inoculation. Blast lesions in the leaves harbour several fungi, bacteria and other biological entities in nature, as co-tenants.

Therefore, the method of considering type '3' lesion as representation of one pathogenic race of *P. oryzae* and type '4' lesion as that of another pathogenic race of *P. oryzae*, is not acceptable (S.E.S. Chart, IRRI 1980).

Veeraraghavan and Premalatha Dath (1976) could not find differences in the pathogenicity of 110 cultures of *P. oryzae* after testing them on plants of international blast differentials considering type '3' or 'C' type lesion with ashy grey centre and brown margin (Padmanabhan et al. 1967) as representing resistance. Padmanabhan (1979) stated that type 'C' lesion of blast is considered as susceptible reaction of the host for distinguishing pathotypes of *P. oryzae* in India.

Veeraraghavan (1975a) suggested that tiny brown spots of the host may be deemed as resistant reaction of the differential while lesions with ashy grey centre should be considered as susceptible of the differential to classify the races of *P. oryzae*. Premalatha Dath and Veeraraghavan (1977) adopting round lesions with purplish brown border and ashy grey centre as susceptibility of the differential could not obtain differences in the pathogenicity of 65 cultures collected from different parts of India during 1975. Veeraraghavan (1980) reported host specialisation in 40 cultures of *P. oryzae* 0,17 (Veer)=IC-17 (L & O) was restricted to susceptible rice varieties having lesions with ashy grey centre and brown margin as susceptible reaction and tiny brown spots or absence of any reaction as that of resistance of plants. These cultures produced an immune reaction on rice cultivars, Te-tep, Zenith, Tadukan and Cheran (*O. sativa*).

Ou and Ayad (1968), Ou et al. (1970) and Ou et al. (1971) utilised the number of infected plants of differentials as the criterion for classification of pathotypes. They considered the reaction of a differential as resistant if the percentage of infected plants was less than 20% of the population and susceptible when the number of infected plants was more than 20%. This method of distinguishing resistance and susceptibility of the differential for classification of pathotypes of *P. oryzae* is not acceptable.

Veeraraghavan (1975a) reported change in pathogenicity in 7 cultures of the pathogenic race IC-1 (L & O) to that of the pathogenicity-pattern IC-17 (L & O) consequent to their storage either in culms of rice or in oat meal agar medium kept at 5°C. The pathogenicity of the cultures of IC-17 (L & O) remained stable adopting the same method of storage. Although circular type of lesions with ashy grey centre and brown margin should be deemed as susceptible reaction of the differential for identification of pathotypes for the investigation to test the extent of stability in *P. oryzae*, he has considered circular lesion with ashy grey centre and brown margin as resistant reaction of the differential. Distinction between resistance and susceptibility of the differential by unreliable methods such as slight difference in the shape of the lesion is not tenable. Hence the change in the pathogenicity of cultures of *P. oryzae* IC-1 (L & O) to that of *P. oryzae* IC-17 (L & O) is not acceptable since the method adopted is not confusion-free Subtle methods lead one to notice illusions.

The investigators who have reported change in pathogenicity have considered lesions with ashy grey centre and brown margin as representing moderate/resistant reaction of the differentials (Goto et al. 1964, Nizekii 1967, Giatgong & Frederiksen 1969, Katsuya & Kiyosawa 1969, Ou 1972, Veeraraghavan 1975a, Kozaka 1979, Ou 1981, Bharadwaj & Singh 1982). Therefore reports of instability in *P. oryzae* by different investigators are not acceptable. Investigators who have reported changes in the pathogenicity of the fungus have not maintained necessary controls. They have not indicated the measures which they have undertaken to ensure/guarantee that the genotype of a differential employed for the first test for stability in pathogenicity and that of the subsequent re-testing remained the same. A difference in the genotype of the differential for the first and the subsequent test would present a situation as though the pathogen has changed its pathogenicity. Utilising type '3' lesion as susceptible reaction there are no reports of instability in the pathogenicity of *P. oryzae* (S.E.S., I.R.RI. 1980)

Considering the lesions caused by *P. oryzae* with ashy grey centre and brown margin as susceptible reaction of the differential none of the investigators on pathogenicity of *P. oryzae* have reported differences among the cultures. The study of pathogenicity of *P. oryzae* utilising rice plants for grouping cultures of *P. oryzae* into pathotypes is sound since they are self-pollinated and renders itself amenable for easy maintenance without change through vegetative propagation. Moreover plants of a particular variety are genetically identical. It is essential to ensure that the cultures of *P. oryzae* are free from contamination or infection before classifying them into pathotypes.

Veeraraghavan and Premalatha Dath (1981) have reported maintenance of uninoculated controls of the differential hosts. Many investigators who have reported pathogenic races in *P. oryzae* did not maintain uninoculated set of differentials as control.

A racial designation of a culture of *P. oryzae* depends on the genotype of the differential host and the method of distinguishing resistant and susceptible reaction of the differential.

None of the investigators proposed a standard for the pathogen. A standard of the pathogen, *P. oryzae* is complimentary to the genotypes of differential hosts. This step is essential to monitor the integrity of the genotype of the differential. The designation of the pathotype is reciprocal to the genotype of the differential host utilised. It is imperative that a culture of the pathogen with the pathotype designation should be utilised for inoculating a set of differentials for distinguishing pathotypes in *P. oryzae*. Thus three sets of differentials are essential to identify

the pathotype of a culture. The standard culture of the pathogen should be utilised to check the correctness of the genotype of a differential/differentials whenever a pathogenic race is identified as verification. While one set of differential would monitor genetic purity another would serve as an un-inoculated check.

The standard culture of *P. oryzae* should be deposited in an international type culture collection with details of accession number and names of differentials, source of the differential hosts and method of identification.

A pathogenic race in *P. oryzae* has to be designated as follows — *Pyricularia oryzae*, O–17 (Veer)=IC–17 (L & O) sensu V.J. (1975a); USDA germplasm.

In view of the existing literature on *P. oryzae* it is obligatory on the part of the investigator to verify the racial designation of *P. oryzae* before utilising it for work lest the label may not represent the host-range/level of pathogenicity of the culture of the pathogen. Unless precautions against errors in execution i.e., wrong seeds, contaminated seeds and disease-escape which might be construed as resistant reaction are undertaken by maintaining a reference culture, reports of pathotypes in *P. oryzae* would remain but that of pseudo-pathotypes only.

A communication on pathogenic races in *P. oryzae* cannot claim validity if it does not give the source of the seed, the accession number and names of differential hosts besides the registration number of the standard culture of the pathogen in a type culture collection of any country or in an international type culture collection.

References

Ahn C J et al. 1962 Studies on the physiologic races of rice blast fungus, *Piricularia oryzae* in Korea; *Seol Univ. J. Biol. Agr. Series* **B11** 77–83

Ainsworth G C and Bisby G R 1945 *Dictionary of Fungi* (Kew, Surrey : Imperial Mycological Institute)

Atkins J G 1962 Prevalence and distribution of pathogenic races of *Pyricularia oryzae* in the US; *Abstr. Phytopathology* **52** 2

——, Bollich C N, Johnston T H, Jodon N E, Beachell H M and Templeton G E 1965 Breeding for blast resistance in the United States; in *Proc. Symp. Rice Blast Disease* (Baltimore, Maryland: John Hopkins Press)

—— et al. 1967 An international set of rice varieties for differentiating races of *Pyricularia oryzae*; *Phytopathology* **57** 297–301

Bandong J M and Ou S H 1966 The physiologic races of *Piricularia oryzae* Cav. in the Philippines; *Philippines Agriculturist* **59** 655–667

Bharadwaj C & Singh B M 1982 Pathogenic variation in *Pyricularia oryzae* in Himachal Pradesh; *Indian Phytopathol.* **35** 167–170

Chiu R J, Chien C C and Lin S Y 1965 Physiologic races of *Piricularia oryzae* in Taiwan; in *Proc. Symp. Rice Blast Disease* pp 245–255

Galvez G E and Lozano T J C 1968 Identification of races of *Pyricularia oryzae* in Colombia; *Phytopathology* **58** 294–296

Giatgong P and Fredericksen R A 1969 Pathogenic variability and cytology of monoconidial subcultures of *Piricularia oryzae*; *Phytopathology* **59** 1152–1157

Gilmour J 1973 Octal system for designating physiologic races of plant pathogens; *Nature* **242** 620

Goto K 1964 Joint work on the races of rice blast fungus *Pyricularia oryzae* Fascide 2 Plant, insect and disease forecast spec; Report 18 Plant Prot. Div. Min. Agric. Forestry, Japan 132 pp

International Rice Research Institute 1980 *Standard Evaluation System* (2nd edn) (Los Banos: IRRI)

Katsuya K and Kiyosawa S 1969 Studies on mixture inoculation of *Pyricularia Oryzae* in rice.II. Inter-strain difference of mixture inoculation effect; *Ann. Phytopathol. Soc. Japan* **35** 299–307

Kiyosawa S 1976 Pathogenic variations of *Pyricularia oryzae* and their use in genetic and breeding studies; *Sabrao J.* **81** 53–67

Kozaka T 1979 The nature of the rice blast fungus and varietal resistance in Japan; in *Proc. Workshop Rice Blast* (Los Banos: IRRI) **81** 137

Latterell F M, Tullis E C and Collier J W 1960 Physiologic races of *Piricularia oryzae* Cav.; *Pl. Dis. Rep.* **44** 679–683

——, Tullis E C, Otten R J and Gubenick A 1954 Physiologic races of *Pyricularia oryzae*; *Phytopathology* **44** 495

——, Marchetti M A and Grove B R 1965 Co-ordination of effort to establish an international system for race identification in *Pyricularia oryzae*; in *Proc. Symp. Rice Blast Disease* 257–274

—— 1975 Phenotypic stability of pathogenic races of *Pyricularia oryzae* and its implication for breeding of blast resistant varieties; in *Proc. Symp. Horizontal Resistance Blast Disease Rice* Oct 1971, CIAT, Cali, Colombia, Series CE-9 pp 199–234

Ling K C and Ou S H 1969 Standardisation of the international race numbers of *Pyricularia oryzae*; *Phytopathology* **59** 339–342

Matsumoto S, Kozaka T and Yamada M 1969 Pathogenic races of *Piricularia oryzae* Cav. in Asian and some other countries; *Bull. natn. Inst. Agric. Sci. Tokyo* **C23** 1–36

Nizekii H 1967 On some problems in rice breeding for blast resistance with special reference to variation of blast fungus; *Recent Adv. Brdg.* **8** 69–76

Ou S H 1972 *Rice Diseases* (Kew, Surrey Commonwealth Mycological Institute) CAB 368

—— 1981 Pathogenic variability in *Pyricularia oryzae*; in *Proc. Symp. Rice Resistance to Blast*; Montpellier, France, March 18–21 1981 pp 175–182

—— and Ayad M R 1968 Pathogenic races of *Pyricularia oryzae* originating from single lesions and monoconidial cultures; *Phytopathology* **58** 179–182

——, Nuque F L, Ebron T T and Awoderu V 1970 Pathogenic races of *Pyricularia oryzae* derived from monoconidial cultures; *Plant Dis. Rep.* **54** 1045–1049

——, ——, —— and —— 1971 A type of stable resistance to blast disease of rice; *Phytopathology* **61** 703–706

Padmanabhan S Y 1979 Breeding for blast resistance in India; *Rice Blast Workshop* (Los Banos: IRRI) 1977 49–61

——, Chakrabarti N K, Mathur S C and Veeraraghavan J 1967 Physiologic specialisation in *Pyricularia oryzae*; *Proc. Indian Acad. Sci.* **B66** 63–73

——, ——, —— and —— 1970 Identification of pathogenic races of *Pyricularia oryzae* in India; *Phytopathology* **60** 1574–1577

Premalatha Dath A and Veeraraghavan J 1977 The present situation of physiologic races of *Pyricularia oryzae*; *Curr. Sci.* **46** 129–130

Sasakii R 1922 Existence of strains in rice blast fungus; *J. Pl. Prot. Tokyo* **9** 631–644

Stakman E C and Harrar J G 1957 *Principles of Plant Pathology* (New York: Ronald Press)

Veeraraghavan J 1975a Stability in *Pyricularia oryzae* Cav; *Proc. Indian Acad. Sci.* **B82** 127–131

—— 1975b A new method of classification and nomenclature of physiologic races of *Pyricularia oryzae* Cav.; *Int. Rice Comm. Newsl.* **24** 128–138

—— 1980 The extent of host specialisation in *Pyricularia oryzae*; *Indian J. Mycol. and Pl. Pathology* **10** 188–189

—— and Premalatha Dath A 1975 Current position of physiologic races of *Pyricularia oryzae* in India; *Curr. Sci.* **44** 19–20

—— and —— 1976 Host-pathogen equilibrium between rice (*Oryza sativa* L.) and its pathogen, *Pyricularia oryzae*; *Curr. Sci.* **45** 333–334

—— and —— 1981 Physiologic specialisation in *Pyricularia oryzae* Cav. in India during 1976–78; *Proc. Indian natn. Sci. Acad.* **B47** 226–228

Yamada M, Kiyosawa S, Yamaguchi T, Hirano T, Kobayashi T, Kushibuchi K and Watanabe S 1976 Proposal of a new method for differentiating races of *Pyricularia oryzae* Cavara in Japan; *Ann. Phytopath. Soc. Japan* **42** 216–219