Plant Pathology Bulletin 3:224-229, 1994

Occurrence, Distribution and Phenology of Seedborne Fungi of Rice (*Oryza sativa* L.) in Certain Provinces of the Philippines

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Accepted for publication: December 30, 1994

ABSTRACT

Misra, J. K., Gergon, E. B., and Mew, T. W. 1994. Occurrence, distribution and phenology of seedborne fungi of rice (*Oryza sativa* L.) in certain provinces of the Philippines. Plant Pathol. Bull. 3:224-229.

A total of 144 rice samples were collected from different sites in Laguna, Batangas, Cavite, Camarines Norte, Camarines Sur, Albay, and Sorsogon (Bicol region) of the Philippines during the dry and wet seasons of 1988-89 and screened for their fungal population using standard blotter method. The screening yielded 39 fungal species belonging to 30 genera infesting both blemished (discoloured) and unblemished (healthy) seeds. The percentage of infestation by different species ranged differently at various locations. Among the different locations, the common fungal species were evenly distributed except for *Pyricularia oryzae, Nakataea sigmoideum* and *Tilletia barclayana* during the dry season. During the wet season, distribution of *Drechslera* sp. and *Microdochium oryzae* were uneven. *T. barclayana* was evenly distributed irrespective of the season. Infestation of both apparently healthy (unblemished) and discoloured (blemished) seeds was highest with *A. padwickii* followed by *Curvularia* sp.

Key words: Distribution; Philippines; Rice; Seedborne fungi.

INTRODUCTION

Rice (*Oryza sativa* L.), a staple food of more than thirty three percent of the world population, suffers from a number of maladies including pathogenic ones. Fungi, one of the important groups of pathogens, cause 55 diseases; of which 43 are seedborne or seed-transmittable (12-15). Furthermore, in recent years, the seed traffic has increased dramatically amongst the international centres and scientists in wake of global cooperation in agriculture to boost crop production and combat hunger. The movement of seeds for commercial purposes has also gained momentum. In the light of these activities and possible risk involved in such movement/business, the awareness regarding the seedborne pathogens has also proportionately increased and should increase further in order to safeguard the danger of introduction or spread of important and devastating pest and pathogens in any area, besides minimizing seed losses during pre and post harvest stages.

In Philippines, where rice is grown as the main food crop under various rice-growing ecosystems, little is in print regarding the seedborne pathogens of rice (9,10,18). Hence the authors undertook a survey of seedborne pathogens of rice in certain provinces of the Philippines during wet and dry seasons of 1988-89 and the results are presented here.

MATERIALS AND METHODS

Moisture content

The moisture content of all the samples was determined at the time of collection using Satake moisture meter.

Collection of samples

One hundred forty four rice seed samples of various varieties were randomly collected in sterilized paper bags from different locations in Laguna, Batangas, Cavite, Camarines Norte, Camarines Sur,

Albay, and Sorsogon (Bicol region) of the Philippines during dry and wet seasons of 1988-89 at the time of harvesting. The samples so collected were brought back to the laboratory as soon as possible and fumigated with 1.2 g phosphine/m^3 for 72 hrs before study. A working sample of approximately 20 g was taken out from each using a standard divider.

Fungal infestation

Four hundred seeds, 200 blemised or discoloured and 200 unblemished or healthy looking ones of each sample, were separately plated onto the moist blotter in 8 cm petri plates for screening fungi, each plate having 25 seeds (1). The plates were incubated at 20 ± 1 C in alternating cycles of 12 hrs darkness and 12 hrs NUV light for 7 days after which time the fungi which appeared over the seeds were examined under the stereo-binocular microscope. The pathogenic ones were specially looked for their occurrence and distribution. Overall variation in the total number of fungi appearing on the seeds during dry and wet seasons was also noted.

RESULTS AND DISCUSSION

The number of samples collected from different provinces during wet and dry seasons of 1988-89 are shown in Table 1. During dry season 91 samples could be collected; the highest being 27 from Camarines Sur while the lowest 2 from Cavite. Fifty three samples could be collected during wet season; the highest 15 was from Laguna while lowest 2 from Camarines Norte. This is because our trip could not coincide with their harvesting dates as the farmers keep on cropping continuously and do not leave the fields fallow. The moisture content of the samples collected ranged between 15–21%. Fungal species detected from the seeds during screening are listed in Table 2 with percent of occurrence and the names of the diseases they are known to cause. As is evident from the Table, a total of thirty nine fungal species belonging to 30 genera could be detected, of which twelve genera are pathogens of rice plant while others are either weak parasites or saprophytes causing grain discolouration syndrome (13). *Alternaria padwickii* (Ganguly) Ellis occurred in the highest percentage (86.80%) followed by *Nigrospora oryzae* (Berk. & Br.) Petch (69.44%), *Alternaria* sp. (62.50%), *Aspergillus niger* van Tieghem (55.55%), *Aspergillus* sp. (55.20%), *A. flavus* Link (52.08%), *Cladosporium* sp. (46.61%), *Curvularia* sp. (48.61%), *Fusarium moniliforme* Sheld. (48.61%), *Penicillium citrinum* Thom (48.61%), and *Tilletia barclayana* (Bref.) Sacc. & Syd. (48.61%) occurring in percentages shown against them in parentheses. The lowest percent of occurrence was of *Pyricularia oryzae* Cav. (2.08%). Others occurred in varying percentages. The fungal flora detected during the present investigation were also encountered by Usha *et al.* (21) while studying the fungal colonization of developing rice grains, except that at harvest they did not detect *Aspergillus flavus* and *A. niger* even at water content between 16.5–17.4%. However, they detected *Penicillium* sp. at low percentage. This variation may be due to differences in the climatic conditions of the countries of investigation as the Philippines remains quite humid even during dry season. That water content is responsible for the disappearance of Aspergilli and some other fungi from the grain at harvest, can not solely be relied upon. Other factors, such as climatic and nutrient availability, etc. at the substrate, are rather more important and relevant than water content alone. And hence our finding too as that of Usha *et al.* (21) suggest that classifying fungi into field and storage fungi should not be taken rigidly rather it can be matter of convenience to group the fungi occurring over the seeds from their development until maturity and in storage which indicates their succession. Presence of *Alternaria*, Aspergilli, *Cladosporium*, *Curvularia*, *Fusarium*, Penicillia, and *Rhizopus* sp. in freshly harvested seeds clearly indicates that these organisms infest the germplasm in the field and continue to stay in/on the seeds in storage, of course up to certain period (9,11). During this period of infestation they damage them to various degrees besides contaminating them by their toxic metabolites (2,4,19,21). Some of them blemish the seeds to various degrees and reduce their germinability, market and milling values (5-11,16,17,22).

TABLE 1. Rice seed samples collected from different provinces of the Philippines during dry and wet seasons of 1988-89

Location	Dry season(DS)	Wet season(WS)
Laguna(L)	14	15
Batangas(B)	6	12
Cavite(C)	2	3
Camarines Norte(CN)	3	2
Camarines Sur(CS)	27	4
Albay(A)	18	8
Sorsogon(S)	21	9
Total	91	53

Range of percent infestation by some important seedborne pathogens during dry and wet seasons has been given in Table 3 for different locations. It can be inferred from the obtained results that at all locations *Alternaria padwickii* infested the seeds in greater percentages than others; lowest infestation, of course, was of *Pyricularia oryzae*. Infestation seems to be affected by the season as well as the locations. This variation appears logical as the provinces looked for are quite variable ecologically as far as rice cultivation is

TABLE 2. Fungal flora detected on rice seeds, their percent occurrence (based on 144 collections) and disease(s) they cause

Fungal flora	Percent occurrence	Disease(s)
Alternaria padwickii (Ganguly) Ellis	86.80	Stackburn
Alternaria sp.	62.50	Grain discolouration syndrome(GDS)
Aspergillus sp.	55.55	GDS
A. flavus Link	52.08	GDS
A. fumigatus Fres.	41.66	GDS
A. niger van Tieghem	55.55	GDS
Cephalosporium sp.	20.83	GDS
Cercospora janseana (Racib.)	41.66	Narrow O. Const. brown leaf spot
Cladosporium sp.	48.61	GDS, leaf spots
Colletotrichum sp.	13.88	Saprophyte
Curvularia sp.	48.61	Black kernel
Bipolaris oryzae (Breda de Hann) Shoem.	41.66	Brown spot
Drechslera sp.	27.77	GDS, leaf spots
Epicoccum purpuracens Ehrenberg ex Schlecht.	10.41	Red blotch of grains
Fusarium moniliforme Sheld.	48.61	Bakanae and foot rot
F. semitectum Berk. & Rav.	27.77	GDS, seed rot
F. solani (Mart.) Sacc.	27.77	GDS, seed rot
Fusarium sp.	34.72	GDS, seed rot
Microdochium oryzae (Hashioka & Yokogi) Samuels & Hallett	20.83	Leaf scald
Leptosphaeria sp.	6.94	GDS, seed rot
Myrothecium verrucaria (Alb. & Schw.) Ditm. ex Fr.	10.41	Myrothecium blotch
Nakataea sigmoidea (Cav.) Hara	13.08	Stem rot
Nigrospora oryzae (Berk. & Br.) Petch	69.44	Minute leaf and grain spot
Penicillium sp.	41.66	GDS
P. citrinum Thom	48.61	GDS
Periconia sp.	13.88	Saprophyte
Phaeotrichoconis crotalariae (Salam & Rao) Subram.	10.41	GDS
Phoma sp.	13.88	GDS
Phyllosticta glumarum (Elli. & Tr.) Miyake	10.41	Glume blight
Pithomyces sp.	20.88	GDS
Pyrenochaeta oryzae Shirai ex Miyake	20.83	Sheath blotch
Pyricularia oryzae Cav.	2.08	Blast
Rhizoctonia sp.	6.94	Sheath blight
Rhizopus sp.	20.83	GDS
Sarocladium oryzae (Sawada) Gams & Hawksw.	41.66	Sheath rot
Tilletia barclayana (Bref.) Sacc. & Syd.	48.61	Kernel smut
Ulocladium sp.	6.94	GDS
Verticillium albo-atrum Reinke & Berthold	17.36	GDS
V. cinnabarinum (Cda.) Reinke & Berth.	13.88	GDS

concerned. At certain locations upland rice growing ecosystem dominates while at others low land or both are present. This variation affects the rice plants and consequently may be the fungi infesting their germplasm. Such variations have also been found by Usha *et al.* (21) and Wu & Dow (23). Important pathogenic fungi infesting healthy and discoloured seeds during dry and wet seasons are tabulated in descending

TABLE 3. Percent range of seed infestation by important pathogens during dry season (DS) and wet season (WS) of 1988-89 at various location (based on the observation of 400 seeds randomly selected)

Fungi	Seed infestation(%)													
	L[1]		B		C		CN		CS		A		S	
	DS	WS	DS	WS	DS	WS	DS	WS	DS	WS	DS	WS	DS	WS
Alternaria padwickii	5-50	0-62	2-25	0-14	1-25	4-31	7-26	11-63	1-81	0-23	4-66	5-68	7-65	5-38
Curvularia sp.	1-34	0-61	2-63	0-31	2-15	1-30	1-16	7-19	0-39	0-41	0-28	1-21	0-20	2-12
Sarocladium oryzae	1-39	0-32	0-14	0-47	1-25	0-32	0-7	5-21	0-26	0-32	0-14	1-25	0-40	1-23
Microdochium oryzae	0-27	0-20	0-1	0-1	0-20	0-25	1-5	0-3	0-4	0-0	0-3	0-1	0-8	0-25
Fusarium moniliforme	0-3	0-22	0-1	0-6	0-10	0-20	0-2	0-12	0-12	0-5	0-38	0-10	0-30	0-4
Bipolaris oryzae	0-1	0-1	0-3	0-2	0-5	0-5	0-1	0-0	0-6	0-0	0-8	0-1	0-1	0-25
Pyricularia oryzae	0-2	0-0	0-0	0-0	0-0	0-0	0-0	0-0	0-0	0-0	0-0	0-0	0-0	0-0
Cercospora janseana	0-1	0-1	0-1	0-0	0-0	0-1	0-1	0-0	0-42	0-0	0-1	0-0	0-5	0-0
Tilletia barclayana	0-1	0-2	0-0	0-19	1-5	0-4	0-1	2-3	0-1	0-24	0-4	0-25	0-2	0-7

[1] Locations: L, Laguna; B, Batangas; C, Cavite; CN, Camarines Norte; CS, Camarines Sur; A, Albay and S, Sarsogon.

TABLE 4. Average(%) infestation by important pathogenic fungi on unblemished (H) and blemished (D) rice seeds (based on the observation made for 400 seeds randomly selected)

Fungi	Seed infestation(%)			
	Dry Season		Wet Season	
	H	D	H	D
Alternaria padwickii	28	31	14	13
Curvularia sp.	8	10	11	10
Sarocladium oryzae	3	2	7	11
Tilletia barclayana	1	5	7	10
Microdochium oryzae	1	2	1	1
Fusarium moniliforme	1	5	1	3
Bipolaris oryzae	1	1	0	1
Pyricularia oryzae	0	0	0	0
Cercospora janseana	0	0	0	0

percentages of their infestation (Table 4). The highest infestation was by *Alternaria padwickii* in both seasons. Discoloured seeds harboured *A. padwickii* in greater number, but its infestation is no way lesser on healthy looking ones as well; others, particularly *Curvularia* sp. were detected mostly from the discoloured ones, possibly because they are predominantly responsible for grain discolouration syndrome (GDS) of the seeds particularly during wet season (13,16,20). Distribution of the fungal forms based on their detection from the seed samples of different provinces has been given in Table 5. It can be deduced from the data that common seedborne fungi such as *Alternaria padwickii, Aspergillus flavus, A. niger, Curvularia* sp., *Fusarium moniliforme, Microdochium oryzae* (Hashioka & Yokogi) Samuels & Hallett, *Nigrospora oryzae* (Berk. & Br.), *Phoma* sp., *Sarocladium oryzae* (Sawada) Gams & Hawksw. and *Tilletia barclayana* are evenly distributed; while others are uneven in their distribution. Such variations may occur due to various factors such as temperature, humidity and edaphic factors, etc. D'Souza & Venkataraman (3) and Wu & Dow (23) have got similar results working in India and Taiwan respectively. However, on the basis of this survey no definite conclusion can be drawn and hence more extensive and intensive surveys of rice seedborne pathogens are warranted.

Variations in the total number of fungi detected in different seasons indicates that they have seasonal pattern of occurrence but it has also been found to be affected by the region also. During wet season more fungi could be detected from the samples of Laguna, Batangas and Cavite while during dry season from the samples collected from Camarines Norte, Camarines Sur, Albay and Sarsogon (Table 6). This result indicates that fluctuation in the number of fungi detected from the seeds depend on the regional climatic factors (23). To confirm this, more detailed surveys are required.

TABLE 5. Distribution of fungal flora in different provinces based on their detection on rice seeds

Fungi	Location						
	L[1]	B	C	CN	CS	A	S
Alternaria padwickii	+[2]	+	+	+	+	+	+
Alternaria sp.	–	–	–	–	+	+	+
Aspergillus sp.	–	–	–	–	+	–	–
A. flavus	+	+	+	+	+	+	+
A. fumigatus	–	+	+	+	+	–	+
A. niger	+	+	+	+	+	+	+
Cephalosporium sp.	–	+	–	–	+	–	+
Cercospora janseana	–	–	–	+	+	+	+
Cladosporium sp.	–	+	+	+	+	–	–
Colletotrichum sp.	–	–	–	–	–	–	+
Curvularia sp.	+	+	+	+	+	+	+
Bipolaris oryzae	+	+	+	+	+	+	+
Drechslera sp.	+	+	–	–	+	–	–
Epicoccum purpuracens	–	–	+	+	+	+	–
Fusarium moniliforme	+	+	+	+	+	+	+
F. semitectum	+	+	–	–	+	–	–
F. solani	+	–	–	+	+	+	–
Fusarium sp.	–	+	+	+	+	+	+
Microdochium oryzae	+	+	+	+	+	+	+
Leptosphaeria sp.	–	–	–	–	–	–	+
Myrothecium verrucaria	+	+	+	+	–	+	–
Nakataea sigmoidea	–	–	–	–	+	–	+
Nigrospora oryzae	+	+	+	+	+	+	+
Penicillium sp.	–	+	+	+	+	+	+
P. citrinum	+	+	–	+	+	–	+
Periconia sp.	+	–	–	–	–	–	+
Phaeotrichoconis crotalariae	+	+	–	+	–	+	–
Phoma sp.	+	+	+	+	+	+	+
Phyllosticta glumarum	+	–	–	+	+	+	+
Pithomyces sp.	+	–	–	–	+	+	+
Pyrenochaeta oryzae	+	–	–	–	+	+	+
Pyricularia oryzae	+	–	–	–	–	–	–
Rhizoctonia sp.	+	+	–	–	+	+	+
Rhizopus sp.	+	–	+	–	–	–	+
Sarocladium oryzae	+	+	+	+	+	+	+
Tilletia barclayana	+	+	+	+	+	+	+
Ulocladium sp.	–	–	–	–	+	–	–
Verticillium albo-atrum	+	+	+	–	+	–	+
V. cinnabarinum	–	–	–	–	+	–	–
Total	25	23	19	22	32	23	28

[1] L, Laguna; B, Batangas; C, Cavite; CN, Camarines Norte; CS, Camarines Sur; A, Albay and S, Sarsogon.
[2] + = Present, – = Absent

TABLE 6. The number of fungal flora detected from rice samples during the dry and wet seasons of 1988-89 in different sites of the Philippines

Location	No. of Fungal flora	
	Dry Season	Wet Season
Laguna	13	25
Batangas	12	23
Cavite	15	19
Camarines Norte	22	14
Camarines Sur	32	15
Albay	23	22
Sorsogon	28	18

ACKNOWLEDGEMENTS

One of us (JKM) is thankful to the International Rice Research Institute (IRRI), PO Box 933, Manila, The Philippines for the award of the fellowship (Post-Doctoral Scientist-2) and Sri Jai Narain Mahavidyalaya authorities for providing leave to avail of the opportunity.

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摘　　要

J. K. Misra[1], E. Gergon[2] and T. W. Mew[2]. 1994. 菲律賓地區水稻種子傳播性眞菌之發生，分佈及其與氣候因子之關係. 植病會刊 3:224-229. (1. 印度 Sri Jai Narain Mahavidyalaya 生物系，2. 菲律賓稻米研究所)

於 1988 至 1989 年的乾、濕兩季，自菲律賓 Laguna, Batangas, Cavite, Camarines Norte, Camarines Sur, Albay 和 Sorsogon (Bicol 地區) 等不同地點採集得到 144 個水稻樣本，利用標準潰潤長出法篩選其寄生眞菌族群。自有污斑及無污斑的種子分別篩選獲得屬於 30 屬的 39 種眞菌。其感染的比率因不同種類眞菌及不同採集地點而有差異。以乾季而言，除了 *Pyricularia oryzae, Nakataea sigmoideum* 與 *Tilletia barclayana* 外，常見之眞菌種類大體上平均分佈各採集地點。而於濕季期間 *Drechslera* sp. 及 *Microdochium oryzae* 的分佈並不平均。*T. barclayana* 則不論乾、濕季節皆呈平均分佈。所有測試種子的感染率以 *A. padwickii* 最高，其次爲 *Curvularia* sp.。

關鍵詞：分佈，菲律賓，水稻，種子傳播性眞菌。