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PATHOTYPE PROFILE OF *Xanthomonas oryzae* pv. *oryzae* ISOLATES FROM THE RICE ECOSYSTEM IN JAVA

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ABSTRACT

At present, bacterial leaf blight of rice caused by *Xanthomonas oryzae* pv. *oryzae* is highly damaging to rice production in Indonesia as most of the existing commercial rice varieties are susceptible to the existing pathotypes of the bacteria. To solve such problems, varietal rotation should be based on information on the existence and dominance of local pathotypes in a particular rice ecosystem. To obtain this information, a total of 117 isolates of *X. oryzae* pv. *oryzae*, collected from West Java, Central Java, and Yogyakarta, were evaluated for their pathotype variation on five differential rice varieties during the dry season of 2000. When disease severity was < 10%, the reaction was classified as resistant (R) and when > 11%, was susceptible (S). The data indicated that 3.42% of the isolates were pathotype III, 12.82% were pathotype IV, and 83.76% were pathotype VIII. In West Java, the bacterial pathotypes III, IV, and VIII were 4.94%, 14.81%, and 80.25%, respectively. In low elevation areas, 4.94%, 9.88%, and 45.68% were pathotypes III, IV, and VIII, respectively and in medium areas, 4.94% were pathotypes IV and 34.57% were pathotype VIII. In Central Java, no pathotype III was found, while pathotypes IV and VIII were as much as 4.52% and 90.48%, respectively. In low elevation areas, no pathotypes III was recovered, and a total of 9.53% and 76.19% were identified as pathotypes IV and VIII, respectively, and in medium areas only pathotype VIII (14.29%) was identified. In Yogyakarta, pathotypes IV and VIII were found. In low elevation areas, 6.67% and 93.33% were pathotypes IV and VIII, respectively and in medium areas, 14.29% and 85.71% were pathotypes IV and VIII, respectively. The data indicated that variation in pathotype composition over different locations was obvious and locally specific resistant varieties to the disease are needed in the management of this important bacterial disease in rice.

[**Keywords:** *Oryzae sativa, Xanthomonas oryzae* pv. *oryzae,* pathotype distribution, bacterial leaf blight]

INTRODUCTION

Bacterial leaf blight caused by *Xanthomonas campestris* pv. *oryzae* (*Xoo*) is one of the most important diseases of rice in most of the rice growing countries. The disease can affect rice plants at any plant growth stages. Infection on the young plant(s), less than one month old, causes wilts, dries, and finally dies (Ou 1985; Mew 1989). The disease occurred on young plants is called *kresek* and its symptom is similar to that caused by stem borer (*Scirpophaga* spp.). Plants infected at later growth stage display leaf blight symptom, which is most easily observed when the plants reach the generative growth stage. Losses up to 35.8% have been reported especially when the plants were infected since the seedling stage (Suparyono and Sudir 1992).

Under tropical condition, varietal resistance is the main control measure available, because there is no other control measure economically effective for this disease (Siwi and Oka 1967; Yamamoto *et al*. 1977). Unfortunately, the control measure becomes ineffective due to pathotype development of the pathogen that able to break down the resistant traits. In Indonesia, the phenomenon was first reported by Oka (1972) when he observed that IR8 and IR5 were free while other rice cultivars such as Arias, Sintha, and Kortina were diseased. Further research indicated that several pathotypes were commonly found in Indonesian rice field such as pathotypes III, IV, and V (Yamamoto *et al*. 1977), as well as III, VI, and VIII (Suparyono *et al*. 1982; Suparyono 1984). It was also reported that the bacterial pathotype III was able to overcome the dominant resistant gene *Xa-4* in IR36 rice variety (Suparyono *et al*. 1982).

At present, most of the existing commercial rice varieties are susceptible to the existing pathotypes, causing the disease become damaging to the rice production in the country. To solve such problems, the strategy of varietal rotation needs to be established. It needs information on the development and distribution of local pathotypes of the pathogen, especially on their existence and dominance in a particular rice ecosystem. This article describes the existence and dominance of pathotypes of *Xoo* in several rice ecosystems in Java.

MATERIALS AND METHODS

Collection of Diseased Leaves

Diseased leaves showing typical bacterial leaf blight symptom were collected from various rice fields over low and medium elevations in West Java, Central Java, and Yogyakarta during the wet season of 1999/2000. In low elevation of West Java, samples were collected from Karawang, Subang, Cirebon, and Indramayu, while in medium elevation were from Kuningan, Ciamis, Tasikmalaya, and Cianjur. In low elevation of Central Java, samples were collected from Batang, while in medium elevation were from Wonosobo and Purbalingga areas. In low elevation of Yogyakarta, samples were collected from Bantul and Kalitirto, while in medium elevation were from Sleman.

Samplings were conducted based on the random sampling method, on crops of 40 days after transplanting (DAT) to approaching maturity, as the disease usually develops well in these plant growth stages. Diseased leaves were detached and put into the paper envelope of 23 cm x 11 cm in size. The envelopes were labeled explaining the variety, location, growth stages, sampling date, and disease severity at the sampling time. Samples were taken into the laboratory and kept in the refrigerator for further process.

Isolation of *Xoo*

Diseased leaves were taken out from the envelope, washed with tap water, and air dried. These clean samples were then cut into small pieces of about 5 mm x 5 mm in size and put in a plate with shallow well containing sterilized distilled water for about 5 minutes, to let the bacterial cells streaming out from the diseased tissues. Using a sterilized ooze needle, the bacterial suspension was streaked onto Petri dishes containing potato sucrose agar (PSA) medium. The plates were incubated in room temperature for 48-72 hours. Yellow bacterial colonies were transferred into slant PSA medium as pure culture and used for further evaluation.

Pathotype Evaluation

Five rice differential varieties (Yamamoto *et al*. 1977), i.e. Kencana, Kuntulan, PB5, Tetep, and Java14 containing different genes for resistance to *Xoo*, were grown in the greenhouse of Indonesian Institute for Rice Reserach (IIRR) during the dry season of 2000. Each variety was directly seeded in pot of 10 liter in volume, containing natural paddy soil. The rice plants were maintained based on the standard rice production system (Suparyono and Setyono 1993). The inoculation was done with 4-needle pricking method on the center of fully developed uppermost leaf blade with bacterial suspension at the concentration of 10^9 cells ml^{-1}. Five plants of each variety were inoculated with each isolate (Yamamoto *et al*. 1977).

Disease Severity Assessment

Disease severity was observed by measuring the length of blight symptom at 14-21 days after inoculation. The severities were expressed as the ratio between the length of blight symptom and the length of the whole leaf, presented in percentage (%).

Data Management

The variables on each variety were presented as the mean disease severity of each bacterial isolate. The reaction of each variety to each isolate was grouped into resistant (R) when disease severity value was <10% and susceptible (S) when disease severity was >11% based on Ezuka and Horino (Yamamoto *et al*. 1977). The grouping of the bacterial isolates into pathotypes (Table 1) was done based on Yamamoto *et al*. (1977).

Table 1. Pathotype grouping of *Xanthomonas oryzae* pv. *oryzae* isolates based on their reaction to five differential rice varieties.

Kencana	Kuntulan	PB5	Tetep	Java 14	Pathotype
S	R	R	R	R	I
S	S	R	R	R	II
S	S	S	R	R	III
S	S	S	S	S	IV
S	R	S	R	R	VI
S	S	S	S	R	VIII

R = resistant (<10% disease severity), S = susceptible (>11% disease severity).
Source: Yamamoto *et al*. (1997).

RESULTS AND DISCUSSION

A total of 117 isolates of *Xoo,* 81 from West Java, 21 from Central Java, and 15 from Yogyakarta, were isolated. Of the 81 isolates from West Java, 49 isolates were collected from low elevation areas (Karawang, Subang, Cirebon, and Indramayu) and 32 isolates were from medium elevation areas (Kuningan, Ciamis, Tasikmalaya, and Cianjur). Of the 21 isolates from Central Java, 18 isolates were collected from low elevation areas (Batang) and 3 isolates from medium elevation areas (Wonosobo and Purbalingga). While of the 15 isolates from Yogyakarta, 8 isolates were collected from low elevation areas (Bantul and Kalitirto) and 7 isolates were from medium elevation areas (Sleman).

Based on their reaction to the five differential rice varieties, 3.42% isolates were identified as pathotype III, 12.82% were pathotype IV, and 83.76% were pathotype VIII (Table 2). In West Java, the composition of the bacterial pathotypes III, IV, and VIII were 4.94%, 14.81%, and 80.25%, respectively. In low elevation areas (Karawang, Subang, Cirebon, and Indramayu), 4.94%, 9.88%, and 45.68% were pathotypes III, IV, and VIII, respectively and in medium areas (Kuningan, Tasikmalaya, Ciamis, and Cianjur), 4.94% and 34.57% were pathotypes IV and VIII, respectively. In Central Java, no pathotypes III was found, while pathotypes IV and VIII were 4.52% and 90.48%, respectively. In low elevation areas (Batang), no pathotype III was recovered and a total of 9.53% and 76.19% were identified as pathotypes IV and VIII, respectively. In medium areas (Wonosobo and Purbalingga) only pathotype VIII (14.29%) was identified. In Yogyakarta, the composition of the bacterial pathotypes IV and VIII were 6.67% and 93.33%, respectively. In low elevation areas (Bantul and Kalitirto), 6.67% and 93.33% were pathotypes IV and VIII, respectively and in medium areas (Sleman), 14.29% and 85.71% were pathotypes IV and VIII, respectively.

The three pathotypes of *Xoo* developed naturally in rice ecosystem in Java. Among the three, pathotype VIII was dominant, followed by pathotype IV (Table 3). The data suggest that local bacterial pathotypes naturally developed and distributed differently across provinces and between low and medium rice ecosystem. Previous report also indicated that the development and distribution of the pathotype groups of *Xoo* were affected by plant growth stages at which diseased leaves were collected. At tillering and panicle initiation growth stages, bacterial pathotype VIII was the most dominant, while at maturity, pathotypes III and IV were the most dominant (Suparyono *et al*. 2003). The dominance of pathotypes VIII and IV indicated the importance of bacterial leaf blight disease in Indonesia, since most of the existing rice cultivars are susceptible to these two groups of pathotypes.

The structures of *Xoo* pathotypes in West Java showed that in Cianjur and surroundings, no pathotype III was found, but there were 15 isolates of pathotype VIII and 4 isolates of pathotype IV. In Ciamis and surroundings, only pathotype VIII was identified, whereas in Cirebon and surroundings, 3 isolates were pathotype III, 3 isolates were pathotype IV, and 25 isolates were pathotype VIII. Similar pathotype groups were found in Subang and surroundings, where pathotypes III, IV, and VIII were identified. In Yogyakarta, 13 isolates were pathotype VIII and one isolate was pathotype IV. In Batang and surroundings, 19 isolates were pathotype VIII and 3 isolates were pathotype IV. The data indicated that the bacterial pathotype VIII dominated the bacterial pathotypes in Java, followed by pathotype IV. While in Ciamis and surroundings only bacterial pathotype VIII developed during the dry season of 2000. The data also showed that bacterial pathotypes III and VIII developed across elevation, while pathotype III only developed in low elevation in West Java.

The bacterial pathotype VIII was dominant in West Java, Central Java, and Yogyakarta. The lower in both diversity and numbers for each pathotype in Central Java and Yogyakarta as compared to those in West Java (Table 3) might correspond to the diversity of the rice cultivars planted and the samples collected. Rice cultivars planted in West Java areas were more divers as compared to those planted in Central Java and Yogyakarta. Diversity in rice cultivars is an indication of diversity in genetic resistance of the cultivars to the pathogen. Such rice diversity affects the development of bacterial strains of *Xoo*. Before 1980, rice cultivars planted by farmers in West Java were dominated by IR36 and the composition of strains of *Xoo* was 30.07%, 9.23%, 3.07%, 60.0%, and 3.07% for pathotypes I, III, IV, VI, and VIII, respectively (Suparyono 1982). Strain III was highly virulent to resistant rice cultivars governed by single resistant gene as in IR36 rice variety. At that time it was hypothesized that the pathotype VIII might replace the dominance of pathotype III in the future (Suparyono *et al*. 1982). Since the dominance of IR36 was replaced by Cisadane due to its susceptibility to the brown planthopper, the occurrence of the disease was less. This was primary due to the field resistance character in Cisadane variety. One of the parental varieties of Cisadane was Pelita I-1 that bears a pairs of dominance genes for resistance to *Xoo* (Suwarno *et al*. 1982)

Table 2. Pathotypes of *Xanthomonas oryzae* pv. *oryzae* collected from several rice growing areas in Java, DS 2000.

Isolate code	Origin	Variety	Severity (%) on differential variety					Pathotype
			Kencana	Kuntulan	PB5	Tetep	Java14	
0001	Cianjur	IR64	49.33 S	39.67 S	35.75 S	59.33 S	17.00 S	IV
0002	Cianjur	IR64	53.33 S	60.25 S	32.50 S	55.50 S	1.00 R	VIII
0003	Cianjur	IR64	51.00 S	65.67 S	30.50 S	56.50 S	1.30 R	VIII
0004	Cianjur	Ketan	56.67 S	62.00 S	33.00 S	49.67 S	1.20 R	VIII
0005	Cianjur	IR64	53.00 S	63.67 S	31.50 S	53.00 S	2.65 R	VIII
0006	Cianjur	IR64	48.00 S	53.83 S	36.25 S	43.00 S	0.40 R	VIII
0007	Cianjur	Local	66.33 S	69.67 S	41.00 S	67.33 S	2.12 R	VIII
0008	Cianjur	Way Apoburu	68.50 S	66.33 S	50.33 S	64.33 S	1.40 R	VIII
0009	Cianjur	Way Apoburu	68.50 S	64.33 S	33.50 S	65.67 S	0.45 R	VIII
0010	Cianjur	IR64	46.67 S	43.17 S	30.00 S	60.00 S	0.20 R	VIII
0011	Cianjur	IR64	65.50 S	81.00 S	50.00 S	68.50 S	0.37 R	VIII
0012	Cianjur	IR64	50.00 S	42.63 S	34.25 S	51.00 S	13.67 S	IV
0094	Cianjur	IRBB2 (Xa-2)	79.50 S	41.00 S	38.00 S	30.00 S	8.85 R	VIII
0095	Cianjur	IRBB 3 (Xa-3)	77.00 S	54.50 S	36.33 S	39.00 S	15.75 S	IV
0096	Cianjur	IRBB 5 (Xa-4)	43.00 S	47.50 S	32.00 S	14.50 S	2.00 R	VIII
0097	Cianjur	IRBB 11 (Xa-11)	58.50 S	49.00 S	28.50 S	27.50 S	11.50 S	IV
0098	Cianjur	IRBB 14	54.50 S	42.50 S	42.50 S	46.00 S	1.75 R	VIII
0099	Cianjur	IRBB 21	58.00 S	44.50 S	35.50 S	22.00 S	4.25 R	VIII
00100	Cianjur	S3428-2D-Pn-5-1	62.00 S	40.50 S	36.00 S	46.00 S	3.00 R	VIII
00106	Karawang	Way Apoburu	65.50 S	46.50 S	43.00 S	38.00 S	3.50 R	VIII
0054	Subang	Cisadane	58.00 S	23.00 S	41.00 S	29.50 S	0.70 R	VIII
0055	Subang	Way Apoburu	44.50 S	61.50 S	33.00 S	46.00 S	0.40 R	VIII
0056	Subang	Way Apoburu	50.67 S	44.50 S	46.00 S	48.67 S	0.20 R	VIII
0057	Subang	IR64	58.00 S	35.25 S	39.33 S	37.00 S	6.00 R	VIII
0058	Subang	Cisadane	30.33 S	50.00 S	38.00 S	53,50 S	4.75 R	VIII
0059	Subang	IR64	50.00 S	29.50 S	35.67 S	29.00 S	3.50 R	VIII
0060	Subang	Way Apoburu	52.33 S	52.00 S	32.50 S	40,00 S	10.00 S	IV
0061	Subang	Way Apoburu	60.00 S	44.50 S	42.50 S	51.50 S	27.20 S	IV
0062	Subang	IR64	52.00 S	53.00 S	33.67 S	44.00 S	3.00 R	VIII
0063	Subang	Way Apoburu	67.50 S	55.33 S	50.00 S	53.50 S	11.25 S	IV
0064	Subang	IR64	53.33 S	44.00 S	41.50 S	60.00 S	26.45 S	IV
0065	Subang	IR64	59.33 S	45.00 S	37.00 S	71.00 S	19.75 S	IV
0066	Subang	Way Apoburu	26.00 S	39.00 S	24.50 S	38.50 S	8.00 R	VIII
0067	Subang	Way Apoburu	44.50 S	39.67 S	31.50 S	48.00 S	1.60 R	VIII
0068	Subang	Muncul	50.50 S	50.50 S	26.50 S	39.00 S	4.50 R	VIII
0069	Subang	Way Apoburu	45.00 S	23.50 S	18.30 S	0.00 R	1.50 R	III
0070	Subang	Ketan	49.00 S	21.50 S	29.50 S	36.00 S	3.00 R	VIII
0072	Subang	IR64	48.00 S	30.50 S	38.50 S	30.50 S	2.35 R	VIII
0073	Cirebon	IR64	52.00 S	22.00 S	37.00 S	36.50 S	0.00 R	VIII
0074	Cirebon	Digul	46.00 S	30.00 S	30.33 S	36.50 S	3.00 R	VIII
0024	Cirebon	Way Apoburu	59.00 S	53.00 S	36.00 S	53.50 S	1.20 R	VIII
0025	Cirebon	IR64 (?)	57.67 S	54.50 S	31.00 S	51.00 S	0.70 R	VIII
0026	Cirebon	IR64	64.00 S	54.33 S	55.00 S	52.33 S	0.00 R	VIII
0027	Cirebon	IR64	56.00 S	53.67 S	39.00 S	54.00 S	1.60 R	VIII
0073	Cirebon	IR64	52.00 S	22.00 S	37.00 S	36.50 S	0.00 R	VIII
0074	Cirebon	Digul	46.00 S	30.00 S	30.33 S	36.50 S	3.00 R	VIII
0075	Cirebon	IR64	34.00 S	47.33 S	40.00 S	16.00 S	1.00 R	VIII
0076	Cirebon	IR64	23.75 S	50.50 S	31.00 S	0.70 R	0.70 R	III
0077	Cirebon	IR64	72.00 S	51.00 S	45.00 S	63.00 S	1.20 R	VIII
0078	Cirebon	IR64	20.90 S	43.33 S	27.00 S	27.50 S	0.00 R	VIII
0079	Cirebon	IR64	50.50 S	36.00 S	25.00 S	30.00 S	9.50 R	VIII
0080	Cirebon	IR64	75.00 S	48.50 S	40.50 S	25.00 S	1.30 R	VIII
0081	Cirebon	IR64	68.00 S	48.00 S	36.00 S	36.00 S	27.50 S	IV
0082	Cirebon	Ketan	32.67 S	31.00 S	38.50 S	32.00 S	1.20 R	VIII
0083	Cirebon	Digul	51.00 S	39.50 S	21.00 S	21.00 S	0.00 R	VIII
0084	Cirebon	IR64	37.00 S	34.67 S	34.00 S	33.00 S	0.00 R	VIII
0085	Cirebon	Digul	61.00 S	59.00 S	40.50 S	24.00 S	5.00 R	VIII
00114	Cirebon	IR64	31.50 S	11.00 S	39.50 S	22.00 S	6.00 R	VIII

Table 2. (continued)

Isolate code	Origin	Variety	Severity (%) on differential variety					Pathotype
			Kencana	Kuntulan	PB5	Tetep	Java14	
00115	Cirebon	Way Apoburu	35.50 S	14.50 S	37.00 S	32.00 S	0.00 R	VIII
00116	Cirebon	Way Apoburu	26.50 S	14.50 S	25.00 S	7.00 R	3.00 R	III
00133	Cirebon	IRBB 10 (Xa-10)	19.50 S	14.50 S	18.50 S	7.50 R	3.00 R	III
0048	Indramayu	IR64	62,50 S	59.33 S	43.50 S	44.00 S	2,30 R	VIII
0049	Indramayu	IR64	57.50 S	37.67 S	41.50 S	48.00 S	16.00 S	IV
0050	Indramayu	Pandanwangi	54.00 S	78.00 S	35.41 S	56.00 S	14.00 S	IV
0051	Indramayu	Way Apoburu	40.33 S	21.67 S	25.33 S	27.00 S	1.50 R	VIII
0052	Indramayu	IR64	45.00 S	49.50 S	37.00 S	43.00 S	0.35 R	VIII
0053	Indramayu	IR64	57.00 S	24.33 S	32.00 S	38.50 S	9.25 R	VIII
00113	Indramayu	IR64	11.00 S	18.00 S	17.50 S	11.50 S	1.50 R	VIII
0015	Kuningan	Local	64.00 S	63.50 S	52.67 S	58.00 S	1.50 R	VIII
0018	Kuningan	IR64	43.50 S	65.33 S	35.33 S	52.50 S	3.47 R	VIII
0019	Kuningan	Ketan lokal	30.00 S	33.67 S	31.33 S	39.67 S	0.50 R	VIII
0020	Kuningan	IR64	59.50 S	53.00 S	43.33 S	44.00 S	0.37 R	VIII
0021	Kuningan	Memberamo	58.50 S	47.00 S	30.67 S	61.00 S	0.50 R	VIII
0022	Kuningan	IR64	44.50 S	59.75 S	36.50 S	43.00 S	1.30 R	VIII
0023	Kuningan	Way Apoburu	50.00 S	43.50 S	32.00 S	50.33 S	1.80 R	VIII
0013	Ciamis	IR64	73.33 S	66.00 S	47.33 S	64.50 S	4.10 R	VIII
0014	Ciamis	IR39 (?)	46.50 S	34.00 S	23.00 S	50.50 S	2.35 R	VIII
0016	Tasikmalaya	Way Apoburu	47.00 S	46.00 S	44.67 S	48.33 S	1.05 R	VIII
0017	Tasikmalaya	IR64	50.00 S	29.00 S	19.00 S	52.00 S	1.65 R	VIII
0035	Batang	Rumput Gajah	47.33 S	57.50 S	14.50 S	52.00 S	1.25 R	VIII
0036	Batang	IR64 (?)	66.00 S	67.00 S	36.33 S	58.67 S	16.00 S	IV
0086	Batang	IR64	62.00 S	33.00 S	41.50 S	27.00 S	0.75 R	VIII
00101	Batang	Widas	67.33 S	50.00 S	40.50 S	31.50 S	3.10 R	VIII
00103	Batang	Ciherang	25.67 S	22.00 S	21.50 S	18.00 S	1.25 R	VIII
00104	Batang	Lalan	54.50 S	64.00 S	34.50 S	6.50 R	3.50 R	VIII
00105	Batang	Mantik wangi	59.50 S	39.00 S	33.00 S	29.00 S	19.00 S	IV
00117	Batang	Kencana	35.50 S	14.50 S	30.00 S	15.50 S	2.90 R	VIII
00118	Batang	IRBB 11 (Xa-11)	31.50 S	10.50 S	28.00 S	22.50 S	1.50 R	VIII
00119	Batang	IRBB 5 (Xa-4)	17.50 S	15.67 S	35.00 S	17.50 S	0.00 R	VIII
00120	Batang	IRBB 2 (Xa-2)	21.50 S	19.00 S	34.33 S	13.00 S	7.00 R	VIII
00121	Batang	Kuntulan	21.00 S	10.33 S	25.67 S	17.00 S	2.80 R	VIII
00122	Batang	Tetep	27.50 S	20.33 S	31.00 S	17.00 S	7.00 R	VIII
00153	Batang	IRBB 2	16.00 S	13.50 S	10.00 S	10.00 S	2.15 R	VIII
00154	Batang	IRBB 5	13.00 S	12.00 S	12.00 S	12.00 S	1.65 R	VIII
00157	Batang	IRBB 14	11.00 S	10.50 S	17.00 S	14.00 S	7.75 R	VIII
00158	Batang	B9890F-CT-B	15.50 S	13.00 S	24.50 S	11.50 S	1.25 R	VIII
00159	Batang	IR64	15.50 S	10.67 S	19.00 S	13.00 S	5.25 R	VIII
0033	Wonosobo	IR99 (?)	58.00 S	58.00 S	35.50 S	54.67 S	0.80 R	VIII
0034	Wonosobo	Barito	54.00 S	62.67 S	33.33 S	61.50 S	1.60 R	VIII
00152	Purbalingga	IRBB 1	25.50 S	10.50 S	17.00 S	10.00 S	8.50 R	VIII
0037	Sleman	?	53.50 S	32.50 S	43.00 S	47.30 S	1.40 R	VIII
0040	Sleman	IR64	13.00 S	24.50 S	27.50 S	39.67 S	1.00 R	VIII
0041	Sleman	Memberamo	51.67 S	60.00 S	47.00 S	68.67 S	0.80 R	VIII
0042	Sleman	Ketan (local)	52.50 S	38.30 S	27.50 S	43.00 S	0.70 R	VIII
0043	Sleman	IR64	65.50 S	57.67 S	46.00 S	52.50 S	0.40 R	VIII
0044	Sleman	Memberamo	57.00 S	34.50 S	45.00 S	45.33 S	0.80 R	VIII
0047	Sleman	Cisadane (?)	68.00 S	58.33 S	46.00 S	49.00 S	15.00 S	IV
0038	Bantul	Memberamo	68.50 S	60.50 S	54,00 S	69.00 S	9.13 R	VIII
0039	Bantul	Merning (local)	54.00 S	60.50 S	46.25 S	62.00 S	1.40 R	VIII
0045	Bantul	IR64	53.00 S	33.50 S	10.00 S	41.00 S	1.30 R	VIII
0046	Bantul	IR64	48.00 S	41.00 S	33.67 S	27.00 S	9.00 R	VIII
00123	Kalitirto	B10393-Mr-5-2-3	60.50 S	54.00 S	42.33 S	34.50 S	6.50 R	VIII
00124	Kalitirto	B9890F-CT-B	67.50 S	26.00 S	42.00 S	25.00 S	3.00 R	VIII
00125	Kalitirto	BI09-Mr-V/4-8-Pn-5	52.00 S	36.00 S	41.67 S	33.00 S	2.25 R	VIII
00126	Kalitirto	B10393-Mr-12-4-2	65.50 S	34.50 S	37.33 S	35.50 S	12.00 S	IV

S = Susceptible; R = resistant

Table 3. The structure of pathotype of *Xanthomonas oryzae* pv. *oryzae* in West Java, Central Java, and Yogyakarta during the wet season of 1999/2000.

Location	Pathotype			Total
	III	IV	VII	
West Java	4 (4.94)	12 (14.81)	65 (80.25)	81
Low elevation	4 (4.94)	8 (9.88)	37 (45.68)	
Karawang	0	0	1	1
Subang	1	5	12	18
Cirebon	3	1	19	23
Indramayu	0	2	5	7
Medium elevation	0	4 (4.94)	28 (34.57)	
Kuningan	0	0	9	9
Ciamis	0	0	2	2
Tasikmalaya	0	0	2	2
Cianjur	0	4	15	19
Central Java	0	2 (4.52)	19 (90.48)	21
Batang (low el)	0	2 (9.53)	16 (76.19)	18
Medium elevation	0	0	3 (14.29)	
Wonosobo	0	0	2	2
Purbalingga	0	0	1	1
Yogyakarta	0	1 (6.67)	14 (93.33)	15
Low elevation	0	6.67	8 (53.33)	
Bantul	0	0	4	4
Kalitirto	0	0	4	4
Sleman (medium el)	0	1	6 (85.71)	7
Total	4 (3.42)	15 (12.82)	98 (83.76)	117

Number in the bracket are percentages over the total in the particular areas.

CONCLUSION

Three pathotypes of *Xoo*, i.e. III, IV, and VIII were commonly observed in West Java, Central Java, and Yogyakarta during the wet season of 2000. Their distribution and dominance varied both within and across provinces. Within province, variation might be due to elevation which determines the temperature and relative humidity, while variation across provinces might correspond mainly to the diversity of rice varieties planted. The structures of bacterial pathotypes of *Xoo* in Java were dominated by pathotype VIII, either in low or in medium elevation rice growing areas. Data also indicated that pathotypes III and IV only developed in low elevation areas. The dominance of pathotype VIII and IV indicated that bacterial leaf blight disease is still a major threat to rice production in Indonesia, since most of the existing rice cultivars are susceptible to these two groups of pathotypes.

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