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PATHOTYPE GROUPING OF *Xanthomonas oryzae* pv. *oryzae* ISOLATES FROM SOUTH SULAWESI AND SOUTHEAST SULAWESI

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ABSTRACT

Bacterial leaf blight caused by *Xanthomonas oryzae* pv. *oryzae* (Xoo) is an important rice disease, and has caused significant economic losses. This research aimed to determine the pathotype grouping and the distribution of Xoo isolates of South and Southeast Sulawesi. In order to obtain the information, 61 Xoo isolates of South Sulawesi and 29 isolates of Southeast Sulawesi were evaluated for their pathotype grouping against 5 diffential varieties. Research results showed that in South Sulawesi there were 2 pathotype groups, namely pathotype IV (32.79%) and pathotype VIII (67.21%). Pathotype VIII was widely distributed over the Western and Central areas of South Sulawesi, whereas pathotype IV was widely distributed over the Southern area. In Southeast Sulawesi, it was found 5 pathotypes, namely pathotypes IV (27.58%), VI (10.34%), VIII (13.79%), IX (20.68%), and X (27.58%), with a limited and scattered distribution pattern on several areas. These results indicate that Xoo pathotype groups in South Sulawesi and Southeast Sulawesi are varied and tend to sift to more virulent pathotypes.

Keywords: bacterial leaf blight, pathotype group, *Xanthomonas oryzae* pv. *oryzae*

INTRODUCTION

Bacterial leaf blight disease caused by *Xanthomonas oryzae* pv. *oryzae* (Xoo) is one of the main diseases of rice in Indonesia (Hifni and Kardin, 1998, Semangun, 2004),and in other rice-producing countries such as Japan, India and Philiphine (OEPP/EPPO, 2007). In Indonesia, the disease could cause yield loss around 20-30% (Kadir *et al*., 2007), or even 70-80% on susceptible varieties during rainy season (Kadir, 1999).

Several studies have shown the variability of Xoo pathotypes or strains in rice-producing countries (Suparyono *et. al*., 2004; Muneer *et. al*., 2007; Keshavarz *et al*., 2011). The shifting of Xoo pathotypes in Indonesia constantly occures. Yamamoto *et al*. (1977 *in* Kadir,1999), reported that the dominant Xoo pathotypes found in rice fields in Indonesia were pathotypes III, IV and V. Research conducted in 1980s found that pathotypes III, VI, and VIII were the dominant pathotypes (Suparyono, 1984), and during rainy season in the years 1999/2000, pathotypes III, IV and VIII in West Java, Central Java, and Jogyakarta were found (Suparyono *et al.,* 2004). Based on Kozaka system, there have currently been 12 Xoo pathotype groups with different levels of virulence found in Indonesia. In line with the overtime shifting of Xoo pathotypes in the fields, the efficiency of using resistant varieties is only temporary and limited to certain areas because the initially non-outstanding pathotypes can become outstanding pathotypes when the suitable host is available.

The spread of bacterial leaf blight disease in a few areas in Indonesia in recent years is believed to be due to the shift of Xoo pathotypes that become more virulent, the availability of susceptible hosts, and the suitability of climate conditions in the fields. Therefore, information on the distribution of Xoo pathotypes on certain areas is very important in designing the disease control strategy and developing rice varieties resistant to the bacterial leaf blight disease.This research aimed to determine the Xoo pathotype groups and their distribution over several rice planting areas in South Sulawesi and Southeast Sulawesi.

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MATERIALS AND METHODS

Sample Collection of Rice Leaves Showing the Symptom of Bacterial Leaf Blight

Samples were taken from several rice planting locations of South and Southeast Sulawesi, during rainy season in 2011. In South Sulawesi, the samples were collected from 15 districts: Gowa, Takalar, Bantaeng, Jenneponto, Bantaeng, Bulukumba, Sinjai, Bone, Soppeng, Wajo, Sidrap, Pinrang, Barru, Pangkep, and Maros. In South East Sulawesi, the samples were taken from Kolaka, Konawe and South Konawe district. Samples were randomly collected over rice planting areas by taking several leaf samples showing bacterial leaf blight symptoms. The leaf samples were put in plastic bags labeled with sampling date, location, and plant growth stage. Samples were transported to the laboratory for further examination.

Isolation of *Xanthomonas oryzae* pv.*oryzae*

Isolation of Xoo from leaf tissues was performed by slicing the infected rice leaves by 0.5 cm x 0.5 cm over leaf area located between infected tissue and healthy tissue. The leaf pieces were sterilized in 70% ethanol for 5 minutes, and then rinsed twice with sterile aquadest. The leaf pieces were then chopped with sterile blade, added with 2 drops of sterile aquadest, and incubated for 5 minutes. The supernant containing bacterial cells from chopped leaves was streaked over Wakimoto medium, and incubated in room temperature for 2-4 days.

Grown bacterial colonies and showing Xoo characteristics (round colonies, mucoid and yellowish) were purified using a quadrant streak method on PSA medium (Potato 30 g, Sucrosa 20 g and Agar 20 g per liter), and incubated for 3-4 days. Purified isolates were kept in PSA medium in *eppendorf* containing 15% sterile glycerol, stored at – 20°C further tests.

Biochemical and Physiological Tests

Biochemical and physiological tests were conducted to make sure that the isolates were Xoo isolates. The tests performed were a gram test with KOH 3%, oxydative-fermentative test, starch hydrolysis test (Kerr, 1980 *in* Rasminah *et al*., 2010), and sensitivity test to $Cu(NO_3)_2$ (Djatmiko and Prakoso, 2010).

Inoculation of *Xanthomonas oryzae* pv. *oryzae* on Differential Varieties

Xoo pathotypes was determined based on Kozaka system developed in Indonesia. The test was conducted in a glass house using 5 differential varieties: Kencana, PB5, Tetep, Kuntulan and Jawa 14 (Yamamoto e*t al.,* 1977 *in* Kadir, 1999). Tested isolates were isolates that were positive for Xoo based on biochemical and physiological tests. Seeds of the 5 differential rice varieties were germinated in plastic boxes containing media mixture of topsoil, rice hull, and organic matter (animal feces) (2:2:1). After 21 days, rice seedlings were moved to 35-cm polybags, one seedling per polybag, and then maintained in a screen house.

Xoo inoculation in tested plants was conducted using a "scissoring method". A sterile scissor was dipped in inoculums suspension (concentration10^8 - 10^9 per ml) and used to cut leaf samples (5 upper fully-opened leaves), about 3 cm from leaf tip. Each Xoo isolate was tested on 2 rice clusters per variety. Observation of disease severity was based on the development of bacterial leaf blight symptoms on inoculated leaves, 14 to 21 days after inoculation.

Observation of Disease Severity and Determination of Pathotype

Disease severity was scored by measuring the ratio between the length of leaves with symptom and the length of overall leaves, stated in percentage (%). Reaction of individual plant to each isolate tested was categorized resistant if disease severity <10%, and susceptible if disease severity >10%. Determination of pathotype was based on a reciprocal relationship between differential varieties and isolates tested (Table 1).

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

Differential Varieties	Pathotype group of *X. oryzae*pv. *oryzae*									
	I	II	III	IV	V	VI	VII	VIII	IX	X
Kencana	S	S	S	S	S	S	S	S	S	S
PB5	R	S	S	S	R	R	S	S	S	R
Tetep	R	R	S	S	R	S	S	S	R	S
Kuntulan	R	R	R	S	S	R	R	S	S	S
Jawa 14	R	R	R	S	R	R	S	R	R	R

Remarks: S=susceptible (disease severity>10%),
R=resistant (disease severity<10%)
Source: Yamamoto (1977 *in* Kadir,1999)

RESULTS AND DISCUSSION

Xanthomonas oryzae pv. *oryzae* Isolates from South Sulawesi and Southeast Sulawesi

Isolation of rice leaves having bacterial leaf blight symptoms resulted in 124 isolates (70 isolates from South Sulawesi and 54 isolates from Southeast Sulawesi) with Xanthomonas characteristics on Wakimoto medium, such as small rounded colonies, mucoid, and yellow in color. Results of biochemical and physiological tests on the 124 isolates indicated that 90 isolates (61 from South Sulawesi and 29 isolates from Southeast Sulawesi) were positive for Xoo, because they had physiological characteristics as shown in Table 2.

Table 2. Characteristic of *X. oryzae* pv*. oryzae* patotipe based on bacteriological test

Tests	Characteristic of *X. oryzae* p v. *oryzae*
Test of KOH 3%	Gram negative
Oxydase test	-
Fluorescence on King's B medium	-
Oxydative/Fermentative of Glucose	oxydative
Starch hydrolysis	-
Sensitivity to 0.0001% of $Cu(NO_3)_2$	+

Remarks: + = positive (gowth), - = negative

Results of biochemical and physiological tests showed that not all isolates were Xoo eventhough they grew on Wakimoto medium and yellow in color. Out of 70 isolates from South Sulawesi, only 61 isolates (87.14%) had Xoo criteria, while only 55.56% out of 54 isolates from Southeast Sulawesi that were positive for Xoo. The low percentage of Xoo positive isolates from Southeast Sulawesi was partly due to the less development of the leaf blight symptoms, causing the difficulty in pathogen isolation. In South Sulawesi, however, the disease severity was high and the symptoms were obvious and specific, therefore the pathogen isolation was less difficult.

Xoo isolates were selected if they met the Xoo criteria, including gram negative reaction, oxidative, unfluorescence on King's B medium, unable to hydrolyze starch, but can grow on PSA medium containing 0.001% $Cu(NO_3)_2$. Liu *et al*. (2006) mentioned that one difference between Xoo causing *bacterial leaf blight* and *X. oryzae* pv. *oryzacola* causing *bacterial leaf streak* was its resistance to 0.001% $Cu(NO_3)_2$.. Xoo isolates, that grew on PSA medium containing 0.001% $Cu(NO_3)_2$, showed good growth and had yellow colonies. The 90 Xoo isolates were collected, and their geographic origins were shown in Table 3

Pathotype Grouping of *Xanthomonas oryzae* pv.*oryzae*

Pathotype grouping of 90 isolates positive for Xoo was shown in Table 3. Out of 61 Xoo positive isolates from South Sulawesi, they were grouped into 2 pathotypes: patotype IV (32.79%) and pathotype VIII (67.21%). Xoo positive isolates from Southeast Sulawesi were grouped into 5 different pathotypes: pathotype IV (31.03%), pathotype VI (10.34%), pathotype VIII (10.34%), pathotype IX (20.70%), and pathotype X (27.59%).

The results of pathotype grouping indicated that the dominant pathotypes in South Sulawesi were pathotypes IV and VIII, while in Southeast Sulawesi were pathotypes IV and X. The dominance of pathotypes IV and VIII in South Sulawesi was similar to the report by Suparyono (2004), where it was stated that the same 2 dominant pathotypes in West Java, Central Java, and Jogjakarta were found. Hifni (1986) previously mentioned that the dominant Xoo pathotype in Indonesia was pathotype III, while Suryadi and Machmud (1987) reported that the dominant Xoo pathotype in Kerawang and Bekasi district was pathotype VI. With the current dominance of pathotypes IV and VIII, this indicates that there has been a shift in Xoo pathotypes towards more virulent pathotypes in several areas in Indonesia.

There was a clear distribution pattern of Xoo pathotypes in South Sulawesi. Pathotype IV was widely distributed in Southern areas of South Sulawesi, such as Gowa, Takalar, Bantaeng, Jeneponto, Bulukumba, and Sinjai district. On the other hand, pathotype VIII occurred in Western and Central areas, such as Maros, Pangkep, Barru, Pinrang, Sidrap, Wajo, Soppeng, and Bone district. Pathotype VIII was also found in Bantaeng, Jeneponto and Bulukumba district.

Table 3. Pathotype groups of *X. oryzae* pv. *oryzae* isolates from South Sulawesi and Southeast Sulawesi

Code of Isolate	Location (Sub District, District)	Disease Severity (%) on Variety										Patho-type Group
		Kencana		PB5		Tetep		Kuntulan		Jawa 14		
XSG01	Bajeng, Gowa	35.20	S	35.25	S	33.35	S	32.25	S	25.45	S	IV
XSG02	Bontonompo, Gowa	43.45	S	32.25	S	35.50	S	30.45	S	21.45	S	IV
XSG03	Bontonompo Selatan, Gowa	42.25	S	37.25	S	35.50	S	25.13	S	25.25	S	IV
XSG04	Bajeng Barat, Gowa	37.50	S	35.50	S	35.50	S	22.50	S	25.13	S	IV
XST05	Pattalassang, Takalar	40.25	S	35.50	S	33.50	S	35.25	S	34.35	S	IV
XST06	Mapakasumbu, Takalar	37.25	S	35.50	S	30.25	S	32.25	S	35.25	S	IV
XST07	Mangarabombang, Takalar	35.50	S	33.50	S	35.25	S	21.35	S	22.25	S	IV
XST08	Galesong Utara, Takalar	35.50	S	35.25	S	32.25	S	15.50	S	17.25	S	IV
XST09	Galesong Utara, Takalar	35.50	S	34.25	S	25.45	S	17.75	S	15.50	S	IV
XST10	Galesong Selatan, Takalar	33.50	S	34.13	S	21.45	S	18.27	S	25.50	S	IV
XSJ11	Tarowang, Jeneponto	45.20	S	35.25	S	25.25	S	35.25	S	15.50	S	IV
XSJ12	Arungkeke, Jeneponto	45.35	S	32.25	S	25.13	S	32.25	S	23.50	S	IV
XSJ13	Batang, Jeneponto	45.25	S	35.50	S	35.25	S	37.25	S	5.25	T	VIII
XSB14	Lamalaka, Bantaeng	35.35	S	35.50	S	32.25	S	35.50	S	3.25	T	VIII
XSB15	Pa'jukukang, Bantaeng	37.25	S	35.50	S	37.25	S	35.50	S	5.50	R	VIII
XSB16	Bissapu, Bantaeng	35.50	S	33.50	S	35.50	S	35.50	S	23.13	S	IV
XSB17	GantaranKenkeng, Bantaeng	37.25	S	33.25	S	35.50	S	33.50	S	21.35	S	IV
XSBK18	Ujung Loe, Bulukumba	37.50	S	35.25	S	35.50	S	25.45	S	25.25	S	IV
XSBK19	Rilau Ale, Bulukumba	37.00	S	32.25	S	33.50	S	21.45	S	23.25	S	IV
XSBK20	Bulukumpa, Bulukumba	37.13	S	25.45	S	35.25	S	25.25	S	2.25	T	VIII
XSBK21	Bulukumpa, Bulukumba	35.25	S	21.45	S	32.25	S	25.13	S	35.25	S	IV
XSS22	Sinjai Selatan, Sinjai	32.25	S	25.25	S	25.45	S	35.25	S	32.25	S	IV
XSS23	Sinjai Selatan, Sinjai	33.25	S	25.13	S	21.45	S	32.25	S	23.20	S	IV
XSS24	Sinjai Utara, Sinjai	35.75	S	30.25	S	25.25	S	20.45	S	25.72	S	IV
XSSP25	Lilirilau, Soppeng	35.13	S	27.65	S	25.13	S	25.13	S	1.50	R	VIII
XSSP26	Lilirilau, Soppeng	34.13	S	35.25	S	25.25	S	35.25	S	0.90	R	VIII
XSSP27	Liliriaja, Soppeng	33.50	S	32.25	S	25.13	S	32.25	S	2.45	R	VIII
XSM28	Simbang, Maros	45.50	S	35.23	S	35.25	S	27.55	S	2.15	R	VIII
XSM29	Simbang, Maros	42.25	S	30.45	S	32.25	S	19.45	S	0.70	R	VIII
XSM30	Bantimurung, Maros	45.45	S	31.25	S	35.25	S	35.25	S	0.90	R	VIII
XSM31	Bantimurung, Maros	35.25	S	25.75	S	32.25	S	32.25	S	1.15	R	VIII
XSM32	Turilake, Maros	35.75	S	25.25	S	37.25	S	25.45	S	1.25	R	VIII
XSM33	Turikale, Maros	37.13	S	25.13	S	35.50	S	21.45	S	1.75	R	VIII
XSB34	Lamuru, Bone	33.25	S	35.25	S	35.50	S	25.25	S	4.35	R	VIII
XSP35	Tiroang, Pinrang	35.13	S	32.25	S	35.50	S	25.13	S	3.22	R	VIII
XSP36	Tiroang, Pinrang	37.25	S	35.25	S	33.50	S	32.25	S	2.50	R	VIII
XSP37	Suppa, Pinrang	40.13	S	32.25	S	25.25	S	37.25	S	2.56	R	VIII
XSSR38	Maritengae, Sidrap	40.25	S	37.25	S	35.25	S	35.50	S	3.00	R	VIII
XSSR39	DuaPitue, Sidrap	42.13	S	35.50	S	32.25	S	35.50	S	2.45	R	VIII
XSSR40	DuaPitue, Sidrap	45.13	S	35.50	S	25.45	S	35.50	S	3.25	R	VIII
XSW41	Tanasitolo, Wajo	42.50	S	35.50	S	21.45	S	33.50	S	4.13	R	VIII
XSW42	Tanasitolo.Wajo	37.25	S	33.50	S	25.25	S	22.35	S	4.56	R	VIII
XSW43	Sabbangparu, Wajo	37.35	S	31.00	S	25.13	S	25.34	S	3.75	R	VIII
XSW44	Maniangpajo, Wajo	32.25	S	32.45	S	27.13	S	25.45	S	2.35	R	VIII
XSBR45	Balusu, Barru	33.45	S	30.35	S	25.45	S	25.50	S	3.45	R	VIII
XSBR46	Balusu, Barru	33.25	S	27.35	S	21.45	S	22.45	S	2.35	R	VIII
XSBR47	Barru, Barru	40.25	S	38.55	S	25.25	S	25.25	S	3.55	R	VIII
XSBR48	Barru, Barru	35.13	S	36.00	S	25.13	S	23.25	S	2.45	R	VIII

Table 3 *(Continued)*

Code of Isolate	Location (Sub District, District)	Disease Severity (%) on Variety										Patho-type Group
		Kencana		PB5		Tetep		Kuntulan		Jawa 14		
XSBR49	Barru, Barru	35.25	S	34.00	S	30.00	S	20.30	S	3.45	R	VIII
XSBR51	Mallusetasi, Barru	37.13	S	26.85	S	21.45	S	23.13	S	1.75	R	VIII
XSBR52	Mallusetasi, Barru	35.75	S	30.00	S	25.25	S	22.30	S	2.35	R	VIII
XSBR53	Soppengriaja, Barru	35.25	S	32.15	S	26.35	S	19.30	S	1.75	R	VIII
XSBR54	Soppengriaja, Barru	34.13	S	25.13	S	27.13	S	23.25	S	2.45	R	VIII
XSPK55	Labakkang, Pangkep	45.23	S	27.50	S	25.13	S	21.20	S	1.50	R	VIII
XSPK56	Labakkang, Pangkep	43.25	S	40.25	S	35.67	S	35.75	S	5.50	R	VIII
XSPK57	Mandalle, Pangkep	37.25	S	35.33	S	23.13	S	22.30	S	2.35	R	VIII
XSPK58	Bungoro, Pangkep	42.13	S	27.25	S	21.35	S	21.35	S	2.50	R	VIII
XSPK59	Minasatene', Pangkep	40.13	S	36.00	S	25.25	S	25.25	S	1.50	R	VIII
XSPK60	Ma'rang, Pangkep	45.25	S	35.35	S	23.25	S	23.13	S	2.50	R	VIII
XSPK61	Segeri, Pangkep	37.13	S	27.50	S	30.25	S	21.35	S	2.50	R	VIII
XTKL01	Samaturu, Kolaka	15.51	S	11.17	S	21.45	S	40.43	S	7.06	R	VIII
XTKL02	Samaturu,Kolaka	25.55	S	4.71	R	73.09	S	27.50	S	9.67	R	X
XTKL03	Samaturu, Kolaka	25.17	S	2.60	R	31.23	S	3.85	R	7.89	R	VI
XTKL04	Wolo, Kolaka	63.86	S	5.06	R	29.76	S	73.58	S	7.11	R	X
XTKL05	Wundulako, Kolaka	21.14	S	2.41	R	10.95	S	30.85	S	0.59	R	X
XTKL06	Wundulako, Kolaka	39.06	S	40.02	S	16.77	S	36.69	S	44.97	S	IV
XTKL07	Pomalaa, Kolaka	20.72	S	4.72	R	25.15	S	35.88	S	7.16	R	X
XTKL08	Ladongi, Kolaka	24,62	S	4.72	R	25.15	S	35.88	S	6.16	R	X
XTKW09	Wonggeduku, Konawe	24.72	S	4.78	R	25.15	S	35.88	S	7.79	R	X
XTKW10	Tongauna, Konawe	40.75	S	3.20	R	44.06	S	25.09	S	8.81	S	X
XTKW11	Tongauna, Konawe	31.33	S	41.74	S	43.09	S	59.72	S	48.71	S	IV
XTKW12	Tongauna, Konawe	31.68	S	41.74	S	43.62	S	56.42	S	46.81	S	IV
XTKW13	Tongauna, Konawe	22.70	S	9.79	R	14.53	S	2.97	R	3.87	R	VI
XTKW14	Uepai, Konawe	53.87	S	5.82	R	17.02	S	37.34	S	8.91	R	X
XTKW15	Wawotobi, Konawe	17.91	S	18.87	S	6.44	R	5.92	R	6.08	R	IX
XTKW16	Unaaha, Konawe	35.50	S	2.57	R	60.28	S	1.51	R	2.09	R	IV
XTKW17	Wonggedeku, Konawe	67.68	S	84.40	S	71.86	S	55.11	S	46.10	S	IV
XTKS18	Landono,Konawe Selatan	57.57	S	51.09	S	3.25	R	47.21	S	3.86	R	IX
XTKS19	Landono, Konawe Selatan	64.86	S	89.99	S	97.60	S	94.33	S	6.21	R	VIII
XTKS20	Landono, Konawe Selatan	28.37	S	37.30	S	58.09	S	41.53	S	16.98	S	IV
XTKS21	Laea, Konawe Selatan	13.57	S	11.90	S	33.79	S	26.63	S	10.85	S	IV
XTKS22	Palangga, Konawe Selatan	24.70	S	67.05	S	37.60	S	18.08	S	5.85	R	VIII
XTKS23	Palangga, Konawe Selatan	19.76	S	10.10	S	60.41	S	52.46	S	22.82	S	IV
XTKS24	Palangga, Konawe Selatan	83.21	S	31.93	S	63.41	S	44.52	S	34.44	S	IV
XTKS25	Palangga, Konawe Selatan	37.84	S	42.96	S	77.57	S	42.06	S	3.07	R	VIII
XTKS26	Lainea, Konawe Selatan	41.93	S	32.52	S	4.61	R	10.78	S	1.21	R	IX
XTKS27	Lainea, Konawe Selatan	19.19	S	14.84	S	5.58	R	16.77	S	6.14	R	IX
XTKS28	Laea, Konawe Selatan	15.06	S	10.33	S	7.51	R	50.21	S	2.11	R	IX
XTKS29	Laea, Konawe Selatan	17.07	S	11.53	S	7.61	R	50.01	S	2.81	R	IX

Remarks: S: susceptible, R: resistant

Table 4. Geographic distributionof pathotype groups of *X. oryzae* pv. *Oryzae*in South Sulawesi and Southeast Sulawesi

Location of Distribution	Pathotype Group					Total Isolates
	IV	VI	VIII	IX	X	
South Sulawesi	**20 (32.79)**	**0**	**41 (67.21)**	**0**	**0**	**61**
Gowa	4 (100)	0	0	0	0	4
Takalar	6 (100)	0	0	0	0	6
Jeneponto	2 (66)	0	1 (34)	0	0	3
Bantaeng	2 (50)	0	2 (50)	0	0	4
Bulukumba	3 (75)	0	1 (25)	0	0	4
Sinjai	3 (100)	0	0	0	0	3
Bone	0	0	1	0	0	1
Soppeng	0	0	3 (100)	0	0	3
Wajo	0	0	4 (100)	0	0	4
Sidrap	0	0	3 (100)	0	0	3
Pinrang	0	0	3 (100)	0	0	3
Barru	0	0	10 (100)	0	0	10
Pangkep	0	0	7 (100)	0	0	7
Maros	0	0	6 (100)	0	0	6
Southeast Sulawesi	**8 (27.58)**	**3 (10.34)**	**4 (13.79)**	**6 (20.68)**	**8 (27.58)**	**29**
Kolaka	1 (12.50)	1 (12.50)	1 (12.50)	0	5 (62,50)	8
Konawe	3 (33.33)	2 (22.22)	0	1 (11.11)	3 (33.33)	9
Konawe Selatan	4 (33.33)	0	3 (25)	5 (41.67)	0	12

Although the surveyed areas were still quite limited, the research results indicated that Xoo pathotypes distributed in South Sulawesi were not too diverse since there were only two pathotypes found. The pathotype distribution seemed to be in line with the geographic distribution, indicating that a wide area was dominated by a certain pathotype. The distribution pattern of Xoo pathotypes in Southeast Sulawesi was quite different from that of South Sulawesi. In Southeast Sulawesi, the pathotype distribution was concentrated in certain locations. However, sometimes between near locations there were different pathotype groups; therefore, within a single district two different pathotype groups were sometimes found. Xoo pathotype distribution in South and Southeast Sulawesi was shown in Table 4.

The difference in the distribution pattern of Xoo pathotype groups between the two provinces was probably caused by several factors. Firstly, the rice planting areas, in certain locations, in Southeast Sulawesi were generally much narrower that the planting areas in South Sulawesi. Secondly, irrigation system of rice planting areas in South Sulawesi was much better and more developed than that of Southeast Sulawesi. The irrigation system could be a good media for the spread of a certain pathotype group over wide areas. In Southeast Sulawesi, paddy rice planting areas are in general scattered (separated by forest, villages, etc), which usually resulted in relatively limited pathotype distribution. Thirdly, rice varieties grown in wide areas in South Sulawesi were relatively uniform, while in Southeast Sulawesi the rice varieties grown were relatively more diverse. Suparyono *et al.* (2004), mentioned that one factor causing more variable Xoo pathotypes in certain locations was the diversity of varieties grown in those locations.

CONCLUSIONS

Xanthomonas oryzae pv. *oryzae* pathotype groups isolated from rice plants planted in South Sulawesi and Southeast Sulawesi during rainy season 2011 are varied and tend to sift to more virulent pathotypes, there are five of pathotype groups. Two pathotype groups were found in South Sulawesi: pathotype IV (32.79%) and pathotype VIII (67.21%). Pathotype VIII was widely distributed over the Western and Central areas of South Sulawesi, whereas pathotype IV was widely distributed over the Southern area. In Southeast Sulawesi, 5 pathotypes were found: pathotypes IV (27.58%), VI (10.34%), VIII (13.79%), IX (20.68%), and X (27.58%), with a limited and scattered distribution pattern on several areas.

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