Research article

Reaction of Different Rice Varieties to Bacterial Blight

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Abstract Rice is the major food crop in Myanmar and bacterial blight is one of the devastating diseases affecting production. In this study, 37 local rice varieties and 41 rice lines were tested at Yezin Agricultural University, Myanmar, to three different isolates of *Xanthomonas oryzae* pv. *oryzae* to evaluate the resistance levels of these different rice varieties. The three bacterial isolates used in this experiment were collected from Zeyathiri, Zabuthiri and Pyinmana townships in Nay Pyi Taw Union Territory. At maximum tillering stage, the uppermost fully expanded leaves were inoculated by the clipping method. Three weeks after the inoculation, the percent leaf area of the inoculated leaves was visually estimated and the disease reaction of the rice varieties determined. The thirty-seven local rice varieties were classified into seven groups, with this grouping based on the reaction patterns to the three isolates. Group VII, which contained two varieties, Nga Sar Kay and Sinthukha, was moderately resistant to Pyinmana isolate and moderately susceptible to the Zeyathiri and Zabuthiri isolates. The rice varieties included in Group I to Group VI showed susceptible reactions to testing with all three isolates. Among YAU rice lines tested, YAU-1211-71-1-1 exhibited moderate resistance to the Pyinmana isolate only. Apart from the line mentioned above, all the other YAU rice lines, did not exhibit resistance reactions to the test isolates. Nga Sar Kay, a local rice variety, has the potential to be used in the future rice breeding programs and YAU-1211-71-1-1 is the promising one to be used in areas where rice bacterial blight disease is prevalent.

Keywords bacterial blight, resistant varieties, rice, *Xanthomonas oryzae* pv. *oryzae*

INTRODUCTION

Rice (*Oryza sativa* L.) is the most widely eaten staple food crop, especially in Asia, and is consumed by more than half the world's population. Unfortunately, rice crops are threatened by a considerable number of diseases (more than 40 diseases) of fungal, bacterial and viral origin, and these diminish rice yields throughout the world (Singh et al., 2013). Among rice diseases, bacterial leaf blight (BLB) caused by *Xanthomonas oryzae* pv. *oryzae* (Ishiyama) (Swings et al., 1990) is one of the most destructive and widespread diseases of rice. In Myanmar, bacterial blight is also one of the most serious diseases present, and every year, its occurrence has been reported from the different rice growing regions throughout the country (Lwin, 2006). Higher losses are common in tropical Asian countries, such as Myanmar, because of the prevalence of virulent pathogen populations and the

susceptibility of the high yielding cultivars in tropical area (Aye et al., 2007). Yield losses due to the disease are estimated to range from 0.5% to 50% (Myint et al., 1983; Win, 2013).

Many control strategies, including various cultural practices, application of various chemicals and systematic use of chemical fertilizers have been attempted in an effort to control bacterial blight disease, but these management tactics have not been very effective. Although chemical control plays an important part in an integrated disease management program, it has a detrimental effect on human health and non-target, beneficial microorganisms. Non-systematic use of agricultural chemicals can also contribute to the emergence of new races of the pathogen and ultimately prove a waste of money for resource limited farmers. The most feasible, effective and economical way of controlling bacterial blight in Myanmar, is the exploitation of the host plant resistance. Moreover, use of resistant varieties is also compatible with other disease control methods. Although research on varietal resistance is conducted irregularly in Myanmar, varietal resistance is probably the most important area to focus on for effective disease management.

OBJECTIVE

This study was conducted to evaluate the resistance levels of different rice varieties and lines to *Xanthomonas oryzae* pv. *oryzae.*

METHODOLOGY

Test Varieties and Preparation of Plants

Thirty-five local rice varieties, and 41 YAU rice lines were used in this study. Manawthukha was used as a 'susceptible' control and Sinthukha was used as a 'resistance' control variety. Seeds of these rice varieties were obtained from the Department of Plant Breeding, Physiology and Ecology, Yezin Agricultural University. Firstly, rice seeds were sterilized in hot water at 56 ˚C for 15 minutes and germination accomplished using the paper towel method. Germinated seeds were sown in 20 cm × 20 cm plastic pots containing sterilized soil, and twenty- one day old seedlings of each of the test varieties were transplanted individually in plastic pots, containing 3 kg of lowland soil, and these were watered as necessary. Fertilizer application was carried out according to the standard methods of managing rice plants.

Bacterial Isolates

Three very virulent isolates (Isolate I, Isolate II and Isolate III which were collected from Zeyathiri, Zabuthiri and Pyinmana townships in Nay Pyi Taw Union Territory) of *Xanthomonas oryzae* pv. *oryzae* were used for inoculation in this experiment.

Inoculum Preparation and Inoculation

Isolates from preserved tubes were sub-cultured on peptone sucrose agar (PSA) (Tsuchiya et al., 1982) medium plates and incubated for two days. The bacterial suspension was prepared by suspending the bacterial mass from PSA plates in sterilized distilled water and adjusted to 10^8 cfu/ml using a Thermo Scientific Evolution 201 Uv-Visible Spectrophotometer. In order to distinguish the inoculated isolates, plants in a pot were bundled into three groups by labelling with different colored ties (Aye et al., 2007). Inoculation was done at maximum tillering stage, by clipping the uppermost fully expanded leaves of five tillers 2-3 cm from the leaf tips with a pre-sterilized pair of scissors, which were then dipped in the bacterial suspension (Kauffman et al., 1973).

Disease Assessment and Data Analysis

Percent leaf area infected on inoculated leaves were visually estimated 21 days after inoculation. Disease reaction of the rice varieties to the bacterial isolates were determined based on the disease scores (IRRI 1988) (Table 1).

Table 1 Standard Evaluation System for Rice (for bacterial blight) (IRRI, 1988)

% Leaf area infected	Score scales	Description
1-5	1	R
6-12	3	MR
13-25	5	MS
26-50	7	S
>50	9	HS

R: Resistant, MR: Moderately resistant, MS: Moderately susceptible, S: Susceptible, HS: Highly susceptible

RESULTS AND DISCUSSION

Reaction of Myanmar Local Rice Varieties

Thirty-seven Myanmar local rice varieties were evaluated for their reaction to three isolates of *Xanthomonas oryzae* pv. *oryzae*. Based on the reaction patterns to these three isolates, 37 rice varieties were characterized into seven varietal groups, Group I-VII is shown in Table 2. Thirteen Myanmar local rice varieties belonging to Group I were highly susceptible to Isolate I and Isolate II, and susceptible to Isolate III. Group II consists of seven rice varieties, which showed moderate susceptibility to Isolate III and were high susceptibility to Isolates I and Isolate II. In Group III, Khao Phee Phan and Thiri Done Pathein were highly susceptible to Isolate I, susceptible to Isolate II and moderately susceptible to Isolate III. Only one variety, Kauk Kyi Shan Ma, showed the same reaction (susceptible) to all three test isolates. Three varieties in Group V were susceptible to Isolate I, highly susceptible to Isolate II and moderately susceptible to Isolate III. Bacterial isolates I, II and III were virulent to all plants in Group VI, including the nine rice varieties which presented susceptible reactions to Isolate I and II and moderately susceptible reactions to Isolate III. Two varieties, namely Nga Sar Kay and Sinthukha, belonging to Group VII, exhibited a moderate resistance reaction to Isolate III and a moderate susceptible reaction to Isolates I and II.

Reaction of Yezin Agricultural University (YAU) Rice Lines

Forty-one varieties of YAU's promising rice lines were also tested for their response to these three isolates of *Xanthomonas oryzae* pv. *oryzae*. According to disease severity, these YAU rice lines were classified into eight groups, Group I-VIII is shown in Table 3. Group I include only the Manawthukha variety, which was highly susceptible to all test isolates. In Group II, three YAU lines showed highly susceptible reactions to bacterial Isolates I and II and a susceptible reaction to Isolate III. The three rice lines included in Group III expressed highly susceptible reactions to Isolate II and susceptible reactions to Isolates I and III. In Group IV, YAU-1201-90-2-2 showed the same reactions to Isolate I and II as in Group III but it displayed a moderately susceptible reaction to Isolate III. The twelve rice lines that belonged to Group V were susceptible to all test isolates. Group VI included nineteen tested lines and they were susceptible to Isolates I and II and moderately susceptible to Isolate III. Two rice lines in Group VII, YAU-1211-116-3-3 and YAU-1211-223-3-2, presented moderately susceptible reactions to the three test isolates. The lowest disease severity values were found in the varieties YAU-1211-71-1-1 and Sinthukha, which belong to Group VIII. Compared to other test varieties, these rated as moderately resistant to Isolate III and moderately susceptible to Isolate I and II.

In the evaluation of the reaction of rice varieties, almost all of the local rice varieties showed susceptible reactions to the three test isolates. Of the 37 Myanmar rice varieties, Nga Sar Kay and Sinthukha, expressed a moderate resistance reaction to Isolate III (Pyinmana) only. This result indicates that these varieties may harbor a gene resistant to Isolate III and so might be useful for

further rice breeding program. In the present study, Sinthukha was moderately susceptible to two isolates (Isolate I and II). Although *Xa21* was used as a broad-spectrum resistance gene (Khush et al., 1990) in its breeding program, the Sinthukha variety which contains the *Xa21* gene, showed a moderately susceptible reaction to two isolates. A similar result was observed by Swamy et al., (2006) who reported that Pusa Basmati 1 and its transgenic derivative PB-*Xa21* were much more susceptible to virulent Mxo isolates than IRBB 21. The present finding is in conformity with the results of (Myint, 2008) and (Maung, 2014) who reported that Sinthukha was susceptible to a test isolate which showed a resistant reaction to IRBB 21.

Table 2 Reaction of thirty-seven rice varieties to three most virulent isolates of *Xanthomonas oryzae* pv. *oryzae*

Sr. No.	Name of local varieties	Disease reaction and Disease severity (%) to bacterial isolate		
		Isolate I (Zeyathiri)	Isolate II (Zabuthiri)	Isolate III (Pyinmana)
Group I				
1	Boke Thwin Phyu	HS (72)	HS (84)	S (43)
2	Khao Lin	HS (59)	HS (56)	S (26)
3	Muyinn Saba	HS (63)	HS (72)	S (30)
4	Yoe Wa	HS (53)	HS (63)	S (29)
5	V_{15}	HS (60)	HS (71)	S (30)
6	Bu Toyl	HS (56)	HS (72)	S (30)
7	Khun Na Yar Po	HS (63)	HS (67)	S (27)
8	Sa Wana	HS (66)	HS (90)	S (28)
9	Japan Ni	HS (73)	HS (66)	S (41)
10	Khao Mae Pan	HS (59)	HS (70)	S (29)
11	Lone Phyu	HS (55)	HS (84)	S (30)
12	Sa Bong Thaw	HS (72)	HS (86)	S (31)
13	Manawthukha	HS (73)	HS (71)	S (49)
Group II				
14	Ant Paw	HS (59)	HS (64)	MS (24)
15	Khao Pi Paung	HS (55)	HS (54)	MS (24)
16	Thu Kha-2	HS (55)	HS (67)	MS (24)
17	Tayote Hmwe	HS (59)	HS (67)	MS (25)
18	Shal Thu Kha	HS (54)	HS (66)	MS (24)
19	Aye Yar Padae Thar	HS (54)	HS (67)	MS (24)
20	Shwe Thwe Yin	HS (51)	HS (60)	MS (24)
Group III				
21	Khao Phee Phan	HS (51)	S (49)	MS (19)
22	Thiri Done Pathein	HS (52)	S (50)	MS (24)
Group IV				
23	Kauk Kyi Shan Ma	S (47)	S (44)	S (26)
Group V				
24	Kauk Kyi	S (48)	HS (60)	MS (17)
25	Khao Kham To	S (39)	HS (64)	MS (22)
26	Shwe War Yin	S (34)	HS (55)	MS (14)
Group VI				
27	Paw (1)	S (50)	S (50)	MS (25)
28	Paw San Hmwe	S (36)	S (39)	MS (21)
29	Khao Lamil	S (42)	S (45)	MS (17)
30	Naung Ta Moe Se	S (46)	S (48)	MS (21)
31	Kun Lone	S (48)	S (47)	MS (25)
32	Hmaw Bi Kyauk Nyin Hmwe	S (42)	S (27)	MS (21)
33	IR 36	S (43)	S (34)	MS (18)
34	Ma Naw Tun	S (50)	S (39)	MS (20)
35	Bu Aung Ban	S (48)	S (45)	MS (23)
Group VII				
36	Nga Sar Kay	MS (19)	MS (24)	MR (10)
37	Sinthukha	MS (16)	MS (14)	MR (8)

Sr. No.: Serial number, MR: Moderately resistant, MS: Moderately susceptible, S: Susceptible, HS: Highly susceptible

Table 3 Reaction of forty-one YAU rice lines and two check varieties to three most virulent isolates of *Xanthomonas oryzae* pv. *oryzae*

Sr. No.	Name of YAU rice lines	Disease reaction and Disease severity (%) to bacterial isolate		
		Isolate I (Zeyathiri)	Isolate II (Zabuthiri)	Isolate III (Pyinmana)
Group I				
1	Manawthukha	HS (84)	HS (90)	HS (81)
Group II				
2	YAU-1214-B-B-B-153-3-1	HS (52)	HS (66)	S (33)
3	YAU-1214-183-3-4-1-1-1	HS (54)	HS (68)	S (36)
4	YAU-1215-S- S- S-77- 2-1	HS (52)	HS (66)	S (30)
Group III				
5	YAU-1201-187-1-2	S (44)	HS (56)	S (26)
6	YAU-1201-1-2-1	S (39)	HS (53)	S (26)
7	YAU-1211-223-3-1	S (39)	HS (72)	S (28)
Group IV				
8	YAU-1201-90-2-2	S (40)	HS (54)	MS (23)
Group V				
9	YAU-1201-179-2-1	S (39)	S (43)	S (32)
10	YAU-1211-22-2-1	S (34)	S (48)	S (27)
11	YAU-1211-118-1-1	S (40)	S (48)	S (28)
12	YAU-1211-211-2-1	S (31)	S (45)	S (29)
13	YAU-1214-S-S-S-77-1-1	S (36)	S (44)	S (26)
14	YAU-1215-B-B-B-139-3-1	S (41)	S (42)	S (31)
15	YAU-1215-B-B-B-153-3-1	S (41)	S (43)	S (27)
16	YAU-1214-183-3-1-2-1-1	S (35)	S (42)	S (31)
17	YAU-1214-183-3-3-1-1-1	S (38)	S (42)	S (28)
18	YAU-1214-183-35-1-1-1-1	S (30)	S (38)	S (26)
19	YAU-1215-73-2-3-1-1-1	S (39)	S (41)	S (29)
20	YAU-1215-B-B-B-168-1-1	S (39)	S (43)	S (27)
Group VI				
21	YAU-1215-S-S-S-40-2-1	S (36)	S (49)	MS (20)
22	YAU-1215-S-S-S-41-1-1	S (29)	S (37)	MS (23)
23	YAU-1215-S-S-S-55-2-1	S (30)	S (34)	MS (21)
24	YAU-1215-B-B-B-10-1-1	S (31)	S (41)	MS (17)
25	YAU-1201-61-3-3	S (27)	S (32)	MS (19)
26	YAU-1201-90-2-4	S (32)	S (37)	MS (25)
27	YAU-1201-121-3-1	S (36)	S (42)	MS (24)
28	YAU-1201-202-1-2	S (30)	S (28)	MS (21)
29	YAU-1201-202-2-2	S (34)	S (41)	MS (24)
30	YAU-1201-202-2-1	S (38)	S (34)	MS (22)
31	YAU-1211-20-1-1	S (33)	S (40)	MS (20)
32	YAU-1211-54-2-1	S (26)	S (32)	MS (22)
33	YAU-1211-95-2-1	S (28)	S (31)	MS (19)
34	YAU-1211-116-3-4	S (33)	S (44)	MS (23)
35	YAU-1211-118-2-1	S (35)	S (44)	MS (18)
36	YAU-1211-154-3-1	S (35)	S (41)	MS (25)
37	YAU-1211-179-3-2	S (32)	S (31)	MS (22)
38	YAU-1214-183-3-1-1-1-1	S (30)	S (39)	MS (22)
39	YAU-1215-80-1-2-1-1-1	S (27)	S (29)	MS (22)
Group VII				
40	YAU-1211-116-3-3	MS (19)	MS (25)	MS (13)
41	YAU-1211-223-3-2	MS (25)	MS (21)	MS (14)
Group VIII				
42	YAU-1211-71-1-1	MS (19)	MS (24)	MR (11)
43	Sinthukha	MS (17)	MS (18)	MR (12)

Sr. No.: Serial Number, MR: Moderately Resistant, MS: Moderately Susceptible, S: Susceptible, HS: Highly Susceptible

As mentioned, in this study, all YAU rice lines except YAU-1211-71-1-1 displayed moderately susceptible to highly susceptible reactions and rice lines differed in reaction with different isolates of the pathogen. The present study reached similar conclusions to Noor et al., (2006), who stated that the *Xanthomonas oryzae* pv. *oryzae* strains which induced a susceptible reaction in one variety of

rice, are not necessarily able to induce similar reaction in other varieties. YAU-1211-71-1-1 and Sinthukha varieties showed moderate resistance to isolate III (Pyinmana) in the present study. The YAU-1211-71-1-1 may also contain a resistance gene (*Xa21*) because it was developed from a cross of Sinthukha, a popular variety which is resistant to bacterial blight disease (and as mentioned, carries the resistance gene *Xa21),* and Long 8, a hybrid rice variety which is high yielding.

CONCLUSION

The Nga Sar Kay and Sinthukha rice varieties and YAU-1211-71-1-1 rice line are moderately resistant to Isolate III (Pyinmana). Nga Sar Kay, considered as a Myanmar local variety, has potential to be used in future rice breeding program. Also Sinthukha and YAU-1211-71-1-1 show good potential for use in disease prone areas, especially in combination with other management practices. The YAU-1211-71-1-1 can be considered as a promising rice line that could be grown in bacterial blight prone areas, again in combination with other management practices. The emergence of a new race is responsible for the removal of many resistant varieties according to the gene-for-gene concept. Therefore, further research such as the investigation of new strains that have arisen in nature and the screening of rice varieties for their resistance or/ susceptibility to that race, need to be constantly and frequently undertaken in the future.

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