January 2022

THE SECOND INTERNATIONAL CONFERENCE ON GENETIC RESOURCES AND BIOTECHNOLOGY: Harnessing Technology for Conservation and Sustainable Use of Genetic Resources for Food and Agriculture

Committees: The Second International Conference on Genetic Resources and Biotechnology

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Preface: The Second International Conference on Genetic Resources and Biotechnology

The Second International Conference on Genetic Resources and Biotechnology, which is the continuation of the first event held in 2018, focuses on topics related to advances in biotechnology to create more opportunities for effective conservation and sustainable utilization of genetic resources for food and agriculture. This year conference's theme is Harnessing Technology for Conservation and Sustainable Use of Genetic Resources for Food and Agriculture. The conference was organized by Indonesian Agency for Agricultural Research and Development (IAARD), Ministry of Agriculture, Indonesia, in collaboration with Indonesian Biotechnology Consortium and held on 24th-25th of May 2021virtually due to the pandemic of COVID-19.

The conference aims to share and exchange current scientific information and technological developments on biotechnology and their applications for conservation and sustainable use of genetic, to encourage and promote quality, efficiency, and modernization of management and utilization of genetic resources, and to facilitate national and international collaboration among participants. There are five scopes discussed in this conference. They are effective management of conservation and sustainable use of genetic resources for food and agriculture, application of genomics and molecular markers for genetic resource conservation and crop adaptation to climate change, application of innovative crop improvement techniques for conservation and sustainable use of plant genetic resources for food and agriculture, plant cell and tissue culture for conservation and effective utilization of genetic resources, and the use of microbial genetic resources as biological control agents of agricultural pests and diseases, and for soil bioremediation.

Five speakers from the United States of America, Japan, India and Indonesia were invited to discuss about their expertise and knowledge on relevant subjects in the plenary sessions. This conference was attended by more than 100 participants including 75 presenters and 44 listeners worldwide. They came from diverse governmental, private, or academic institutions and also scientific communities. The presented materials have undergone peer review processes and only qualified papers were selected. Furthermore, all papers were subjected to double blind peer-review and expected to meet the scientific criteria of significance and academic excellence to be published in a conference proceedings indexed in a well-known, reputable service.

We would like to express our sincere gratitude to our speakers, presenters and all participants for their contributions in this conference. We would also like to express our appreciation for the generosity of our sponsors that support this conference: PT CropLife, PT ITS Science Indonesia, PT Fajar Mas Murni and PT Prima Instrument Analitika. Lastly, special thanks to all committee members for their exceptional work and contributions in the conference and publication.

Chair of Organizing Committee

Dr. Toto Hadiarto

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Resistance to brown planthoppers (*Nilaparvata lugens* Stål) in rice accessions originated from Sumatra Island, Indonesia

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Dodin Koswanudin, Nurul Hidayatun and Muhamad Ace Suhendar

Resistance to Brown Planthoppers (*Nilaparvata lugens* Stål) in Rice Accessions Originated from Sumatra Island, Indonesia

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Abstract. Brown planthoppers (BPH, *Nilaparvata lugens* Stål) is considered as the main pest in rice plantation in Indonesia, including Sumatra Island. An Integrated Pest Management (IPM) by using resistant varieties is one of the best approaches to control the pest. Local germplasm offers source of gene for the development of resistant varieties. This study was subjected to observe the resistance of local rice varieties originated from Sumatra Island, Indonesia to BPH. The evaluation was carried out using seedling test method. A total of 85 rice accessions of IAARD-ICABIOGRAD Gene Bank collected from Sumatra Island were assessed in a randomized experimental design with three replications. IR 42 and IR 64 were used as susceptible check, whereas PTB 33 was used as resistant check for BPH. Scoring and determination level of resistance were conducted according to Standard Evaluation System of IRRI. The results showed that 5 and 14 rice accessions were highly resistant and resistant to BPH, respectively. There was no correlation observed between the level of BPH resistance and the origin of the accessions. The existences of some highly resistant local rice accessions identified in present study are potential sources for the development of BPH resistant varieties to support the implementation of IPM and agricultural development in the region.

INTRODUCTION

Rice planthoppers that were major threats to the Green Revolution have again returned as the most significant pests in most of Asia [1]. Most rice-producing countries in East and Southeast Asia have incurred losses due to rice planthoppers outbreaks over the last 10 years [1]. Brown planthoppers (BPH, *Nilaparvata lugens* Stål.) is one of the major pest in rice production. Insect infestations are especially severe in rice, which grows in warm, humid environments. Indonesia, as well as China, Vietnam, Thailand, Philippines, and Malaysia, is among the most affected by the BPH attacks [2] and BPH was categorized as the major pest constraint in rice production in Indonesia [3].

This small insect found mainly on the base of rice plants above the water level. The insects suck the plant sap from leaf sheathes and cause damage. Aside of the damage by the sucking mouthpart, BPH also transmit viruses, which cause yellowing of leaves that leading to died plants in patches called 'hopper burn' [1, 4]. Severely damaged plants with hopper burn can lead to crop loss up to 100% [5].

Farmers generally use chemicals to overcome pest attacks and the utilization of chemical pesticides has become the most widely performed. However, when over or misused, application of chemical pesticides have negative impacts, both for the farmers, for the rice farming and for food security [1], including health hazards associated with the application of chemicals, pest resistance to the chemicals, and secondary pest outbreaks [1, 6]. Pest resistance was reported in some studies. In some regency in Java, study showed the relationship between pesticides applications and level of damage by BPH attacks [7, 8].

Growing awareness of the negative impacts of over-use of chemical pesticides has led to the idea of an environmentally friendly approach of Integrated Pest Management (IPM), a sustainable, science-based, decision-

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making process that combines biological, cultural, physical, and chemical tools to identify, manage, and reduce risk from pests and pest management tools and strategies in a way that minimizes overall economic, health, and environmental risks [9]. This ecologically based insect control by managing insect population low has been practice for a long time [10, 11] and Indonesia has a successful history in implementation IPM in the period of 1989–1999, before then an outbreak was reported in 2009 [7]. Since then, efforts to implement IPM to overcome the pest problem has been continued, including the development of designing policies on controlling pest and disease that are relevant to the principles of IPM [12]. In this integrated approach in safeguarding national rice production, among the fundamental strategy in managing BPH pests is the use of resistant varieties [13].

Many studies have reported the importance of utilization of resistance varieties as one of approaches in the IPM [1, 3, 5]. However, the development of BPH resistant cultivars was very difficult. According to Baehaki [11], to inhibit changes in the biotype of the brown planthoppers, cultivars with horizontal or polygenic resistance genes are required. Rotating cultivars with different resistance level is important to delay directional selection. One alternative to develop new cultivars is by using local resistant accessions. This accession can be used as the resistance gene donor parent in the development of new cultivars [3]. The strategy of utilization of pest-resistant cultivar is considered as the first line defense in IPM [11].

In Indonesia, after Java, Sumatra is the second most developed region in agriculture [14]. A favorable climate, especially a well-distributed high rainfall, has facilitated agricultural development [14]. This third largest island in Indonesia produces approximately 31% of Indonesia's GDP [15]. However, despite of this achievement, some provinces in Sumatra are less sufficient in rice production. For example, Riau Province is still depending to other provinces to meet the rice demand [16, 17]. Assessment on land allocation analysis revealed that more than 25 million ha of the current forested land can be converted into perennial tree plantations or used for agroforestry or annual crops [14]. Thus, chance for development of rice plantation to support rice sufficiency of this region is widely open.

This study was subjected to observe the resistance of rice accessions originated from Sumatra Island to BPH. Information of this potential character in each accession will support its utilization, especially in order to develop new insect resistant varieties to support agricultural system especially in Sumatra Island.

MATERIALS AND METHODS

The research was conducted at the Pest Detection Laboratory and greenhouse of Indonesian Center for Agricultural Biotechnology and Genetic Resources Research and Development (ICABIOGRAD), under Indonesian Agency for Agricultural Research and Development (IAARD) in 2017–2020. A total of 85 rice accessions of IAARD-ICABIOGRAD Gene Bank originated from eight provinces in Sumatra Island, i.e. Aceh, North Sumatra, Riau, Jambi, Bangka Belitung Islands, and Lampung, were evaluated for their resistance to BPH. The BPH population was reared in IR 64 and IR 42 rice varieties. The seedling test method was conducted in a randomized block experimental design with three replications. Rice variety of PTB 33 was used as resistant check, whereas IR 42 and IR 64 were used as sensitive checks.

Rice seeds (30 seeds per accessions) were sown in a row in wet soil medium within a 25 cm × 35 cm × 20 cm plastic box. Three to four of BPH nymphs of the third to fourth instar stadia were infested individually on 7-day-old seedling. The seedling was confined with plastic gauze. Observation of the parameters was conducted when the susceptible checks showed symptoms of 90% damage. The symptoms of damage were observed by referring to IRRI-SES method [18], such as the occurrence of partial to pronounced yellowing and increasing severity of stunting, wilting, to death of rice plants.

The scale used for scoring the level of plant damage caused by BPH was as follows: 0 = no injury detected; 1 = very slight injury; 3 = the first and the second leaves of most plants partially possessing yellowing, or orange tips and slight stunting; 5 = pronounced yellowing and stunting or about 10 to 25% of the plants wilting or dead and remaining plants severely stunted or dying; 7 = more than half of the plants dead and remaining plants wilting, severely stunted; 9 = all plants dead [18, 19]. Based on its respective score, each rice accession was then categorized as highly/very resistance, resistance, medium resistance, intermediate, medium susceptible, susceptible, and highly (very) susceptible according to Heinrich [18, 19] with some minor modification.

RESULTS AND DISCUSSIONS

Response Stability of Control Varieties across the Years

The stable response to BPH indicated by the performance of check rice varieties used in this study. The rice varieties IR 42 and IR 64 were very susceptible and susceptible to BPH, respectively, while PTB 33, a resistant check variety, was moderately resistant to resistant (Table 1). The relatively stable response of the control varieties across different years indicated that there was no bias in the screening result, and thus, confirmed the stability of the screening method.

TABLE 1. Responses of check rice varieties to brown planthoppers (*Nilaparvata lugens* Stål) in four years.

Year of evaluation	Variety name	Score	Description
2017	IR 42	9.00	HS
2017	IR 64	9.00	HS
2017	PTB 33	3.00	MR
2018	IR 42	9.00	HS
2018	IR 64	8.60	S
2018	PTB 33	2.50	R
2019	IR 42	8.33	S
2019	IR 64	9.00	HS
2019	PTB 33	2.33	R
2020	IR 42	9.00	HS
2020	IR 64	8.67	S
2020	PTB 33	1.67	R

HR = highly resistant, R = resistant, MR = medium resistant, MS = medium susceptible, S = susceptible, HS = highly susceptible.

Resistance to BPH in Sumatra Rice Accessions

The level of resistance of rice accessions were originated from Sumatra Island varied widely. The scores of plant damage observed in present study were ranged from 0.5 to 9 with an average value of 5.5. Based on scoring range, it showed that rice accessions were grouped into six categories. Their level of resistance to BPH ranged from very/highly susceptible (HS), susceptible (S), moderately susceptible (MS), moderately resistant (MR), resistant (R), and highly resistant (HR). The majority of rice accessions have resistance levels that are categorized as susceptible and intermediate (Fig.1, Table 2).

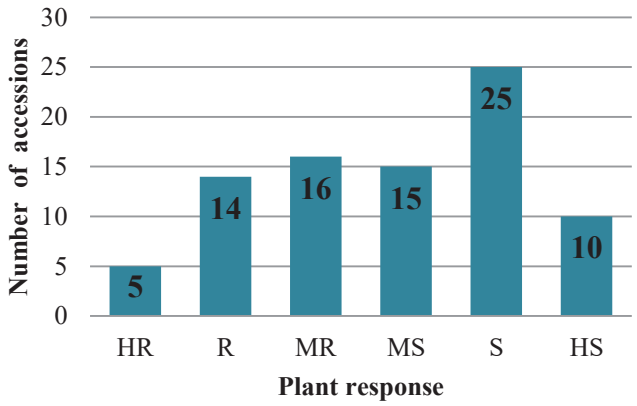

FIGURE 1. Group of resistance level to brown planthopper (*Nilaparvata lugens* Stål) reared in IR 64 and IR 42 rice varieties in Sumatra rice accessions. HR = highly resistant, R = resistant, MR = medium resistant, MS = medium susceptible, S = susceptible, HS = highly susceptible.

The level of BPH resistance in Sumatra rice accessions observed in present study showed no correlation with their province of origin. No province has rice accession with a uniform level of resistance. North Sumatra Province, for example, has rice accessions which showed very resistant respond to BPH, but it also had rice accessions categorized as highly susceptible to BPH. Five rice accessions possessing a highly resistance response to BPH were identified in rice accessions collected from North Sumatra and Jambi Provinces. Meanwhile, a total of 33 resistant rice accessions (17 resistant and 16 moderately resistant accessions) were observed in those from all the seven provinces (Table 2). The susceptible and moderately susceptible rice accessions were originated from the seven provinces, whereas the highly susceptible accessions came from North Sumatra, Jambi, and Bangka Belitung Islands.

TABLE 2. Resistance of Sumatra rice accessions to brown planthopper (*Nilaparvata lugens* Stål) reared in IR 64 and IR 42 rice varieties.

No.	Accession number	Accession name	Province	Score	Description
1	05020-30984	Runteh	Bangka Belitung Islands	3.67	MR
2	05020-30985	Mayang Pandan	Bangka Belitung Islands	7.00	S
3	05020-30986	Raden	Bangka Belitung Islands	8.33	S
4	05020-30987	Mukut	Bangka Belitung Islands	4.33	MR
5	05020-12276	Tampay	Jambi	7.33	S
6	05020-12841	Ampek Bulan	Jambi	8.33	S
7	05020-12843	Ampek Panjang	Jambi	8.33	S
8	05020-15320	Padi Kuning	Jambi	5.67	MS
9	05020-15321	Padi Putih	Jambi	9.00	HS
10	05020-30444	Dewi	Jambi	1.54	R
11	05020-30445	Madu 2	Jambi	1.04	R
12	05020-30447	Semur	Jambi	0.92	HR
13	05020-30448	Super	Jambi	1.32	R
14	05020-30449	Pontianak	Jambi	1.26	R
15	05020-30450	Sereh	Jambi	2.39	R
16	05020-30936	Rimbun Daun	Jambi	3.33	MR
17	05020-30937	Kuning	Jambi	5.67	MS
18	05020-30938	Kusut	Jambi	1.33	R
19	05020-15399	Suluh Baloh	Lampung	7.00	S
20	05020-15414	Blitung 2	Lampung	7.00	S
21	05020-15419	Goyang Rindu	Lampung	4.00	MR
22	05020-15426	Mundungan	Lampung	6.33	MS
23	05020-15440	Sedang Menawan	Lampung	5.33	MS
24	05020-15446	Serang	Lampung	7.67	S
25	05020-30995	Sicantik	Lampung	6.67	MS
26	05020-30996	Sirenik	Lampung	5.67	MS
27	05020-12742	Si Geupai	Aceh	8.33	S
28	05020-20360	Sirendah	Aceh	5.00	MS
29	05020-20362	Cantik Senior	Aceh	6.33	MS
30	05020-30426	Sanbei	Aceh	1.16	R
31	05020-30427	Rom Mokot	Aceh	1.14	R
32	05020-30428	Ramos	Aceh	1.82	R
33	05020-30499	Pade P-66	Aceh	2.74	R
34	05020-30500	Pula gajah	Aceh	4.92	MR
35	05020-30930	Sigupai	Aceh	3.00	MR
36	05020-30931	Rias Bengkok	Aceh	3.00	MR
37	05020-30965	Sigupay Abdya	Aceh	3.33	MR
38	05020-30966	Sanbay Simelue	Aceh	5.00	MS
39	05020-20682	Sipulo Angkola	North Sumatra	5.67	MS
40	05020-20808	Ramos	North Sumatra	4.67	MR
41	05020-30430	Sibosur	North Sumatra	0.86	HR
42	05020-30431	Sitappe	North Sumatra	0.84	HR

No.	Accession number	Accession name	Province	Score	Description
43	05020-30433	Madisde	North Sumatra	2.36	R
44	05020-30434	Moro ‘o	North Sumatra	0.50	HR
45	05020-30435	Nari-Nari	North Sumatra	2.37	R
46	05020-30436	Siregi	North Sumatra	0.77	HR
47	05020-30437	Vali Howa	North Sumatra	1.67	R
48	05020-30860	Condong Merah	North Sumatra	9.00	HS
49	05020-30861	Sirambat	North Sumatra	8.33	S
50	05020-30862	Sigambiri Merah	North Sumatra	9.00	HS
51	05020-30863	Sirapat	North Sumatra	9.00	HS
52	05020-30866	Penuh Baru	North Sumatra	9.00	HS
53	05020-30867	Sipenuh Lama	North Sumatra	9.00	HS
54	05020-30870	Sitamba	North Sumatra	9.00	HS
55	05020-30872	Sigompol	North Sumatra	7.67	S
56	2017-31	Sigabe Raya	North Sumatra	9.00	HS
57	2017-8	Sodori	North Sumatra	9.00	HS
58	05020-30792	Malaysia Wangi	Riau	6.00	MS
59	05020-30794	Padi Telor (Coklat)	Riau	6.67	MS
60	05020-30795	Padi Induk	Riau	8.33	S
61	05020-30801	Padi Kecik 2	Riau	8.33	S
62	05020-30803	Padi Kecik 9	Riau	7.67	S
63	05020-30805	Padi Kecik 11	Riau	8.33	S
64	05020-30807	Padi Kecik 14	Riau	8.33	S
65	05020-30809	Padi Kecik 16	Riau	7.00	S
66	05020-30810	Padi Kecik 25	Riau	7.67	S
67	05020-30815	Padi Putih 2	Riau	7.67	S
68	05020-30824	Pulut	Riau	9.00	HS
69	05020-30825	Sendani 2	Riau	8.33	S
70	05020-30873	Serayu 1	Riau	7.67	S
71	05020-30934	Padi burung	Riau	4.00	MR
72	05020-30935	Anak Daro	Riau	3.00	MR
73	05020-31001	Padi Siam Malaysia	Riau	3.33	MR
74	05020-31003	Padi Sendani	Riau	3.33	MR
75	05020-31004	Padi Kupatali	Riau	8.00	S
76	05020-09709	Randah Cupak	Riau	8.00	S
77	05020-04082	Randah Sasak	West Sumatra	7.00	S
78	05020-30451	Siranting	West Sumatra	3.91	MR
79	05020-30453	Batu Bara-1	West Sumatra	2.46	R
80	05020-30455	Bareh Kuniang	West Sumatra	6.67	MS
81	05020-30940	Maritik Nabara	West Sumatra	7.00	S
82	05020-30941	Siranting-2	West Sumatra	3.33	MR
83	05020-30970	Kemis	West Sumatra	4.67	MR
84	05020-30971	TW	West Sumatra	6.67	MS
85	05020-30972	Setangkai	West Sumatra	6.00	MS

HR = highly resistant, R = resistant, MR = medium resistant, MS = medium susceptible, S = susceptible, HS = highly susceptible.

The existence of accessions with highly resistant response to BPH is a remarkable finding. These five varieties showed higher resistance to BPH compared to the resistant check variety, PTB 33. The PTB 33, widely known as resistant variety originated from Kerala, India, confers resistance genes against three biotypes of BPH [20]. Two of the resistant genes existed in PTB 33 are *bph2* and *bph3* [21]. At the phenotypic performance, this variety displayed high levels of antixenosis and tolerance to BPH [22] and also contained high oxalic acid and low sucrose, two biochemical factors that contribute to the resistance mechanism of rice plants to BPH [21]. With these resistance characters, PTB 33 has been used as a source of genes in breeding [23].

The availability of resistant rice accessions from Sumatra Island is potential as a source of genes in supporting the development of superior varieties with resistance to major pests. In addition, direct use of resistant varieties can also be programmed in agricultural system. The utilization of those respective varieties in the development of IPM based agricultural systems in the Sumatra region will be easier to implement, considering that these varieties have been adapted to this region. Given the suitability of land in the region [14], the availability of resistant local varieties will bring opportunities and support in developing environmentally safe agricultural system.

Prior to its use in costly breeding programs, however, the presence of resistant genes in rice accessions is further required to be confirmed at molecular level. The use of molecular markers associated with BPH resistance genes in rice is expected to confirm types of particular genes existed in each respective variety precisely. In addition, screening with different BPH populations is also needed to identify the possibility of multiple resistances to various existing BPH biotypes. Checking across different biotypes is very important, given the dynamic development of BPH strains. It was reported that until 2006, the population of BPH in nature had fluctuated from biotype 1 to biotype 4 [3]. Aside from molecular confirmation, observation on other traits will also be beneficial to validate the plant resistance. Pest resistant and/or pest tolerant cultivar typically possess physical, morphological, or biochemical characters that reduce the plant's attractiveness or suitability for the pest to feed, develop, or reproduce successfully [11].

CONCLUSION

Rice accessions from Sumatra Island possess different level of resistance to BPH, from highly susceptible to highly resistant. Five rice accessions were identified as highly resistant against BPH and they can be potentially utilized to support sustainable agriculture especially in Sumatra region accompanied with additional data such as other importance agronomical traits.

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