West Sumatera brown rice resistance to brown planthopper

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Abstract. Rice is the main staple food for half of the world's global population. One of the superior rice variety indicators is resistance to brown planthopper. The study was aimed to analyze several West Sumatera rice varieties against brown planthopper. The research was conducted in the screen house, Faculty of Agriculture, Andalas University, Padang, Indonesia from April to October 2018. A completely randomized design was used in this study. Nine rice genotypes and one control variety were used in this assay. The treatment was replicated three times. The result showed that Batang Sungkai was the best genotype in resistance based on the attack intensity.

1. Introduction

Rice [Oryza sativa L.] is the main staple food for Asian people and also consumed by people in other countries such as America and Europe [1]. Ninety percent of Indonesian people consume rice as the main dietary food [2]. The demand for rice also increases in Indonesia every year along with the increasing Indonesian population but it is not supported by the increase in total production. In Indonesia, the demand for rice is 32 million tons/year and national production is just 31.5 million tones [3]. Many efforts have been done so far to increase national rice production such as releasing superior varieties. One of the newly released rice varieties is brown rice.

Brown rice is favorite rice among the urban community. Brown rice is nutritious but has a lower calory compared to the common rice [4]. One hundred grams of brown rice contains about 7.5 g protein, 0.9 g fat, 77.6 g carbohydrates, 16 mg calcium, 163 mg phosphorus, 0.3 g iron, 0.21 mg vitamin B1, and anthocyanin [5]. The awareness of people, especially the urban community on healthy lifestyle results in an increase in the demand for brown rice annually [6]. Indonesia is no exception, the increase is observed nationwide including in the Province of West Sumatra.

West Sumatera is a region in Indonesia that lies in the equator line. The position makes this region is rich with exotic genetic diversity. One of the germplasms from West Sumatera is brown rice. Several data reported that many potential rice germplasms are originated from this region. Ten local brown and black rice genotypes are from West Sumatra. Other data reported 9 brown rice cultivars from Solok District, West Sumatra [7]. These reports indicate that West Sumatra possesses plenty of brown rice genotypes which is the potential to be developed into superior rice varieties. One of the main problems in cultivating rice is the pest attack that could reduce yield significantly is brown planthopper.

Brown planthopper [Nilaparvata lugens [Stal.] is one of the most important pests devastating rice crops, causing a significant yield loss. In West Sumatra, brown planthopper attack caused an almost 100% reduction in the rice yield [8]. Not only damage the plant, but the brown planthopper is also a vector of rice viruses such as rice grassy stunt virus and rice ragged stand virus [9]. One of the plant breeding goals is to obtain resistant variety to biotic factors such as brown planthopper. Current
studies and exploration of rice varieties from West Sumatera barely give us a clear insight on rice resistance to brown planthopper. The study was aimed to analyze the West Sumatera brown rice resistance to brown planthopper.

2. Materials and methods

2.1. Place and time of the experiment
The research was conducted in the greenhouse, Faculty of Agriculture, Andalas University, Padang, West Sumatera, Indonesia from April to October 2018.

2.2. Brown rice resistance assay
A completely randomized design was used in this treatment. Nine brown rice genotypes namely: Sibandung, Padi Gogo, Air Dingin, Batu Kangkung, Siarang, Perbatasan, Sitiung II, PG, and Pido Manggih and one control genotype IR-42 were used as a treatment in this study. The treatments were replicated 3 times. The assay was started from the propagation of brown planthopper. IR-42 rice seeds [a hopper-susceptible rice variety] were germinated on a seedbed [30 x 20 x 5 cm]. Fifteen days after planting [DAP], rice plants were transferred to plastic pots [diameter 15 cm; height 18 cm] with 4 plants per pot. Urea fertilizer [0.35 g/pot] was applied to 21 DAP-plant. At 30 DAP, rice plants were placed in an insect shield container made of wood covered with plastics materials. The base of the insect shield was covered with a sheet of plywood, and the top of the shield was covered with a gauze sheet. There were 5 insect shields [60 x 60 x 60 cm] and each shield contained 6 pots. Ten pairs of adult brown planthopper biotype 3 were placed inside the shield. The IR-42 rice plants were replaced weekly during the experiment. All rice plants were grown in the screen house [10]. Rice seeds were germinated on a seedbed [30 x 40 x 5 cm]. Fourteen DAP plants were transferred to pots [diameter 15 cm; height 18 cm], each pot was planted with 1 plant. Urea fertilizer [0.35 g/pot] was applied to 21 DAP-plant. Rice resistant level was determined and classified based on the extent of plant damage as shown in Table 1.

| Score | Symptoms | Range  | Resistance level |
|-------|----------|--------|------------------|
| 0     | No damage| -      | Highly resistant |
| 1     | Mild damage, yellow lines appears on the first leaf | ≥ 1-3 | Resistant |
| 3     | The first and second leaves yellow | ≥ 3-5 | Moderately resistant |
| 5     | The leaves yellow, growth inhibited, wilted, and half of the plants are dead | ≥ 5-7 | Moderately susceptible |
| 7     | More than 50% of the plants are dead, and the rest are alive but the growth is stunted | ≥ 7-9 | Susceptible |
| 9     | All plants are dead | ≥ 9 | Highly susceptible |

Source: International Rice Research Institute (IRRI) [1988] [8]

2.3. Data analysis
Data were analyzed using Duncan’s New Multiple Range Test (DNMRT) at a significance level of 5%.

3. Results and discussion
The result showed that 1 resistant genotype to brown planthopper was obtained, designated as genotype Sibandung. Five slightly genotypes were obtained in the assay [Table 2]. The resistant and slightly resistant genotypes were potential to be developed as superior genotypes against brown
planthopper. The symptom could be seen by the discoloration of the plant into brown and the wilt leaves and finally died. Brown planthopper sucks plant sap and finally caused the death of plants [11]. The brown planthopper sucks the plant sap and reduce chlorophyll and leaf protein content and finally also reduce photosynthetic rates in plant [12]. Nymph and adult of brown planthopper suck the plant sap and cause stunting, yellow leaf, wilt and finally the plant died. This symptom was called hopper burn [13] [Figure 1].

![Figure 1. Hopper burn symptom of brown rice: a] Batu Kangkung, b] Sitiung II, c] PG](image)

The different responses of brown rice to brown planthopper varied. Resistant and slightly resistant genotypes have a rather hard stem and coarse leaf surface. The hard and coarse plant structure makes the brown planthopper difficult to suck the plant sap, which eventually leads to nymph death due to starvation. Potassium, calcium, and silicone are elements that contribute to the toughness of the plant cell wall structure [lignin and cellulose] [10][14].

Table 2. West Sumatera brown rice resistance to brown planthopper

| Genotype            | Score | Criteria     |
|---------------------|-------|--------------|
| BM Sibandung        | 1     | Resistant    |
| BM Perbatasan       | 3     | Slightly resistant |
| Padi Gogo           | 3     | Slightly resistant |
| BM Pido Manggih     | 5     | Slightly resistant |
| BM Air Dingin       | 5     | Slightly resistant |
| BM Siarang          | 5     | Slightly resistant |
| BM Batu Kangkung    | 7     | Susceptible  |
| BM PG               | 7     | Susceptible  |
| BM Sitiung II       | 7     | Susceptible  |
| IR-42 [Control genotype] | 7     | Susceptible  |

Table 2 shows that there were also susceptible genotypes. The three susceptible genotypes are, Batu Kangkung, PG and Sitiung II. There are three mechanisms of plant resistance: antixenosis [preference and non-preference], antibiosis, and tolerance [15]. We argue that the susceptible
genotypes to the hopper attack have low antibiosis compounds. Besides, the genetic factor plays an important role in rice resistance to brown planthopper. A rice gene called $Bph14$ can activate salicylic acid activity, induce callose deposition and boost the trypsin inhibitor production. Altogether these responses suppress the hopper’s appetite, inhibit their growth and decrease the hopper’s lifespan [16]. Another gene $Bph15$ is believed to contribute to the resistance of rice to brown planthopper. Based on genetic analyses, six miRNAs profile of this gene regulate rice development and defense response to brown planthopper [17].

4. Conclusion
Brown rice variety Sibandung was the only resistant genotype in the study. Five slightly resistant genotypes were also obtained from the study. These genotypes were Perbatasan, Padi Gogo, Pido Manggih, Air Dingin, Siarang, and Batu Kangkung.

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