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Resistance Of Local Rice Genotypes Against Brown Planthopper Pest In Kuantan Singingi Regency

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ABSTRACT

World rice production lost 25% each year due to damage caused by insect pests, such as leafhoppers. One of the efforts to control the brown planthopper is to use resistant local genotypes. This study aims to determine the intensity of attack and the level of resistance of twenty-four local genotypes in Kuantan Singingi Regency against brown planthopper pests. This study used a one-factor, completely randomized design method with four replications. The treatment factors tested were 24 local rice genotypes in Kuantan Singingi Regency plus one resistant variety (Inpari 13) and one susceptible variety (TN1). The results showed that all of the tested genotypes were 100% attacked by brown planthoppers with different levels of attack intensity. Based on the level of attack intensity, a mild category was found, and based on the 2013 IRRI SES, a genotype with resistance criteria was found, namely the genotype Paddy Sironda Putih (PL01), Paddy Singgaro Merah (PL06), Paddy Kuning Umur Panjang (PL07), Paddy Ros (PL08), Paddy Samo Putih (PL09), Paddy Limbayang (PL10), Paddy Sokan Umur Panjang (PL12), Paddy Singgam Putih (PL14), Pulut Benai (PL17), Paddy Kuning (PL21), Paddy Gondok (PL22) and Paddy Katiok Putih (PL24). The level of attack intensity in the moderate category was found in the genotypes Paddy Saronda Merah (PL02), Pulut Hitam (PL04), Paddy Ronda Putiah (PL05), Pulut Benai (PL13), Paddy Singgam Kuriak (PL15), Pulut Kari (PL16), Paddy Putih (PL19), Pulut Lupo Ka Laki (PL20) and Paddy Saronda Kuning (PL23). The level of attack intensity in the severe category was found in the genotypes Paddy Pandan Wangi (PL03), Pulut Karate (PL11), and Paddy Kuning (PL18).

Keywords*: local rice genotype, brown planthopper pest, resistance*

1. INTRODUCTION

Rice production in each region generally fluctuates. This is due to the limiting factors that can affect the amount of rice production, including climatic factors and pests. Brown planthopper (Nilaparvata lugens Stal) is a pest that often causes rice harvest failure (Permadi & Nadimin, 2010). Rice fields that are being planted with rice in several areas in Kuantan Singingi Regency have experienced brown planthopper pests and have greatly disrupted the growth and development of rice plants and their results. This brown planthopper has plastic properties that can easily adapt to any environment. According to Widiastuti (2009), brown planthoppers are categorized as poikilothermic animals, the animals whose body temperature is influenced by environmental conditions.

Based on Permana (2016)**,** the main host for this pest is the rice plant. This pest can cause death to rice plants through direct interaction by sucking plant fluids or through a disease that is transmitted when eating. According to Darmadi & Alawiyah (2018), apart from sucking the host's fluids, the brown planthopper also has a role as a vector for the spread of grass dwarf and empty dwarf viruses.

Baehaki, and, Munawar (2013) said, factors that support the development of brown planthoppers are the use of nitrogen fertilizers, a suitable climate, and tight planting techniques. Therefore, the climatic conditions in the location where they live will affect the presence of brown planthoppers. The life cycle of the brown planthopper consists of eggs, nymphs, and adult male and female macroptera. When the brown planthopper matures, it has two forms; short-winged and long-winged. The spawning period for short-winged planthoppers is 3-4 days and for long-winged planthoppers, it is 3-8 days (Permana, 2016)**.** Darmadi & Alawiyah, (2018) pointed that in tropical areas, especially the island of Java, the brown planthopper is capable of carrying out four to five generations in one planting period.

Efforts to control brown planthoppers can be made by using resistant varieties. Resistant varieties assembled through the plant breeding process can use local genotypes as a source of resistance genes. In addition, these genotypes can also be used as a source of germplasm.

The results of local rice exploration in Kuantan Singingi Regency obtained 26 local rice genotypes and among the 26 genotypes, two genotypes did not grow. Farmers also did not plant these genotypes, so that there are 24 genotypes left today (Ezward et al., 2021). Based on molecular characterization, it was found to have 5 groups at 81% similarity. Furthermore, the genotype was tested for its resistance level to biotic and abiotic stresses, one of which was the brown stem planthopper attack resistance test. This study aims to determine the intensity of attack and the level of resistance of twenty-four local genotypes of Kuantan Singingi Regency against brown planthopper pests.

2. RESEARCH METHOD

This research was carried out from May 2021 to October 2021. A total of 24 local rice genotypes from Kuantan Singingi Regency were tested for resistance to brown planthopper pests at the Insect Bioecology Laboratory and in the Greenhouse of the Plant Protection Department, Faculty of Agriculture, Andalas University. The method used was a one-factor completely randomized design (CRD) with 4 replications. The treatment factors tested were 24 local rice genotypes plus 1 resistant variety (Inpari 13) and 1 susceptible variety (TN1), which can be seen in Table 1.

Tabel 1. Twenty-four (24) local rice genotypes in Kuantan Singingi Regency and Comparative Varieties

Genotipe Code	Name of Genotipe	Origin	
		Village	**District**
PL01	Paddy Sironda putih	Pl. Madina	Kuantan Hilir
PL02	Paddy saronda merah	Pl. Kumpai	Pangean
PL03	Paddy Pandan wangi	Pauh Angit	
PL04	pulut hitam	Pauh Angit	
PL05	Paddy ronda putiah	Pauh Angit	
PL06	Paddy singgaro merah	Tebarau Panjang	Gunung Toar
PL07	Paddy kuning umur panjang	Tebarau Panjang	
PL08	Paddy ros	Tebarau Panjang	
PL09	Paddy samo putiah	Tebarau Panjang	
PL10	Paddy limbayang	Tebarau Panjang	
PL11	pulut karate	Peboun Hulu	Kuantan Mudik
PL12	Paddy sokan umur panjang	Peboun Hulu	
PL13	pulut benai	Peboun Hulu	
PL14	Paddy singgam putih	Peboun Hulu	
PL15	Paddy singgam kuriak	Peboun Hulu	
PL16	pulut kari	Kinali	
PL17	pulut benai	Kinali	
PL18	paddy kuning	Kinali	
PL19	Paddy putih	Kinali	
PL20	pulut lupo ka laki	Pasar Inuman	Inuman
PL21	Paddy kuning	Pasar Inuman	
PL22	Paddy Gondok	Pasar Inuman	
PL23	Paddy saronda kuning	Sikakak	Cerenti
PL24	Paddy katiok putih	Sikakak	
Comparator Resistance(AY)	Inpari 13	National Varieties	
Vulnerable Comparator (AZ)	TN1	National Varieties	

Description: **Ezward *et al* (2021)**

The research consisted of two stages:

1. Brown Planthopper Imago Propagation

The activity was carried out at the Insect Bioecology Laboratory, Faculty of Agriculture, Andalas University to prepare for the propagation of brown planthopper imago. Propagation was done by collecting brown planthoppers from the field that attacked rice varieties IR 42 using an aspirator. Then they were cultured in the Insect Bioecology laboratory, using the IR 42 variety. Before being transferred to a jar filled with water as high as 2 mm, the rice seeds of the IR 42 variety were first

soaked for 24 hours and then air-dried for 2 hours. The water level is kept in a position to cover the rice seeds. After the rice seedlings were 5-7 days old, 10 pairs of brown planthopper imago from the collection were put into each culture jar. During the breeding of brown planthoppers, the laboratory must be protected from predators (especially ants and spiders). About 7–10 days later, 1st instar nymphs will appear before developing into the next stage.

2. Brown Planthopper Nymph Investment

Research activities in the Plant Protection Greenhouse, Faculty of Agriculture, Andalas University. The stages of the activities were as follows: First, preparing the planting media. The planting media used were Red-Yellow Podsolic soil (PMK) and manure. The seeding and planting media was a mixture of soil and manure (2:1 v/v). For the nursery, the medium then placed in the sprout cup. While for the planting medium, it was placed in 5 kg pots and arranged in a greenhouse. Then the planthopper cover was made with a size of (W x W x H) = 4 m x 1 m x 1.5 m. The lid was made of gauze on the top of the mylar plastic side. The test plant in the hood can be seen in Figure 1.

Figure 1. Genotype Test in the Hood

Furthermore, in greenhouse nursery activities, rice seeds were soaked in water for 12 hours, then planted in the nursery cup that had been provided. Seeds were maintained until they are 21 days old, then transferred to 5 kg pots.

Then the plants were maintained with urea, SP-36, and KCl fertilizers. aged 7 days after planting. Urea at 75 kg/ha, SP-36 at 100 kg/ha, and KCl at 50 kg/ha. (Balai Besar (BB) Penelitian Tanaman Paddy, 2021)**.**

At the age of 30 days after seeding, 24 local genotypes plus 1 resistant variety (Inpari 13) and 1 susceptible variety (TN1) were invested in 624 instar WBC nymphs (8 WBC nymphs = 2-3 instars multiplied by 3 seeds per pot multiplied by 26 test genotypes). The first observation was carried out 1 week after investing the brown planthopper up to 60 days after planting. Then watered every day.

Observation

1. Attack Percentage (%)

Observations on the development of the percentage of attacks based on Darmadi & Alawiyah, (2018)**,** were carried out by looking at the symptoms of attacks on rice plants. Symptoms of the first attack by the brown planthopper were marked by a yellow discoloration on the oldest leaf blades, and a large amount of honeydew was found. Observations were made 1 day after the infestation process with an observation time interval of 1 time per week. To calculate the percentage of attacks using the following formula:

$$P = \frac{a}{b} \times 100\ \%$$

Description:
P : attack percentage (%)
a : the number of rice clumps affected by WBC
b : the number of rice clumps observed

2. Attack Intensity (%)

Observations on the development of attack intensity based on Darmadi & Alawiyah (2018) were carried out 1 day after the infestation process with an observation time interval of 1 time a week. This observation was completed until 90% of the TN1 variety seedlings showed dead symptoms. Calculation of attack intensity using the formula below:

$$I = \Sigma \frac{(ni \times vi)}{Z \times N}$$

Description:
I : attack intensity
ni : the number of affected parts of the rice plant on the score i
vi : the scale value of each part of the plant observed on the score i
Z : highest score
N : the number of rice observed

The scoring categories used to determine the intensity of attacks are presented in Table 2.

Table 2. Categories of rice resistance to the intensity of brown planthopper attack

Scale	Damage Percentage	Category
0	0	Normal
1	1 – 25	Light
2	25 – 50	Medium
3	50 – 75	Heavy
4	>75	Very heavy

Source : **Natawigena, (1989)**

3. Resistance Level

Observations on the level of resilience based on the Standard Evaluation System for Rice (SES) of the International Rice Research Institute (IRRI) in 2013 are presented in Table 3.

Table 3. The scale and criteria for the level of resistance of local rice genotypes against brown planthopper pests based on the 2013 edition of the Standard Evaluation System for Rice (SES IRRI).

Scale	Description	Criteria
0	No damage	Highly resistant
1	Very light damage	Resistant
3	The first and second leaves of most plants are partially yellow	Moderately Resistant
5	Leaves yellowing severe and stunted or about 10% - 25% of plants withered	Moderate
7	More than 50% of the plants wilt or die, and the remaining plants are severely stunted or dried out	Vulnerable
9	All dead plants	Very vulnerable

Source : **SES IRRI (2013).**

3. RESULTS AND DISCUSSION

Attack Percentage, Attack Intensity, and endurance level score

The results of testing the resistance of local rice genotypes in Kuantan Singingi Regency against brown planthopper pests can be seen in the observation of the intensity and scoring of the resistance level. The results of testing the resistance of local rice genotypes in Kuantan Singingi Regency against brown planthopper pests can be seen in Table 4.

Table 4. The level of resistance of local rice genotypes to brown planthopper pests

Genotype Code	Name of Genotipe	Attack intensity	Category	Score	Criteria
PL01	Paddy Sironda putih	17,85	Light	1	Resistant
PL02	Paddy saronda merah	25,39	Medium	3	Moderately Resistant
PL03	Paddy Pandan wangi	60,95	Heavy	9	Very vulnurebla
PL04	Pulut hitam	38,63	Medium	5	Medium
PL05	Paddy ronda putiah	27,57	Medium	3	Moderately Resistant
PL06	Paddy singgaro merah	17,30	Light	1	Resistant
PL07	Paddy kuning umur panjang	21,67	Light	1	Resistant
PL08	Paddy ros	24,80	Light	1	Resistant
PL09	Paddy samo putiah	7,78	Light	1	Resistant
PL10	Paddy limbayang	7,73	Light	1	Resistant
PL11	Pulut karate	51,92	Heavy	9	Very vulnurebla
PL12	Paddy sokan umur panjang	22,11	Light	1	Resistant
PL13	Pulut benai	31,39	Medium	5	Medium
PL14	Paddy singgam putih	11,64	Light	1	Resistant
PL15	Paddy singgam kuriak	40,33	Medium	5	Medium
PL16	Pulut kari	35,36	Medium	3	Moderately Resistant
PL17	Pulut benai	12,90	Light	1	Resistant
PL18	Paddy kuning	54,34	Heavy	9	Very vulnureble
PL19	Paddy putih	29,48	Medium	3	Moderately Resistant
PL20	Pulut lupo ka laki	42,28	Medium	9	Very vulnureble
PL21	Paddy kuning	10,48	Light	1	Resistant
PL22	Paddy Gondok	23,75	Light	1	Resistant
PL23	Paddy saronda kuning	41,35	Medium	9	Very vulnureble
PL24	Paddy katiok putih	17,42	Light	1	Resistant
Resistance Comparator	Inpari 13	23,13	Light	1	Resistant
Resistance Comparator	TN1	65,45	Heavy	9	Very vulnureble

Description: Category of attack intensity (Light, Medium Heavy, Very Heavy), according to Natawigena (1989). The scale and criteria for the level of resistance (Resistant (T), Moderately Resistant (AT), Medium (S), Vulnerable (R), Very Vulnerable (SR), against brown planthopper pests based on SES IRRI (2013).

Natawigena (1989)**,** stated that the criteria for assessing the intensity of damage, the score was zero (0) and the percentage of damage was zero (0) in the normal category. In the mild category, a score of one (1) percentage of damage ranged from 1–25. Score two (2) damage percentages ranged from 25 to 50 in the medium category. Score three (3) damage percentages between 50 and 75 were classified in the heavy category. A score of four (4) percentage of damage > 75 indicated that the damage is severe.

Rice plants that were attacked by brown planthoppers showed symptoms of the attack, that was the color of the leaves and stems turning yellow, then turning straw brown, and finally the whole plant looking like it was doused with yellow-brown hot water and dries up (hopperburn). Rice plants attacked by brown planthopper nymphs can be seen in Figure 2.

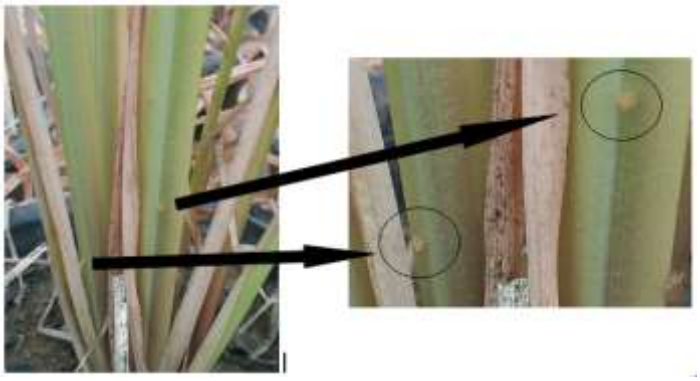

Figure 2. Planthopper nymphs on experimental plants in the greenhouse

The results showed that all of the tested genotypes were 100% attacked by brown planthoppers with different levels of attack intensity. The level of severe damage experienced by the susceptible check variety was TN1 (65.45%), attack intensity was 60.95% on the Pandan Wangi rice genotype (PL03), 54.34% attack intensity on the Yellow Rice genotype (PL18), and 51 attack intensity. ,92% in Pulut Karate (PL11) genotype. The level of mild damage experienced by the resistance check was the Inpari 13 variety, the genotypes of White Sironda Rice (PL01), Singgaro Red Rice (PL06), Longevity Yellow Rice (PL07), Ros Rice (PL08), White Samo Rice (PL09), Rice Limshadow (PL10), Sokan Longevity Rice (PL12), White Singgam Rice (PL14), Pulut Benai (PL17), Yellow Rice (PL21), Gondok Rice (PL22) and White Katiok Rice (PL24). This was because the morphology of the four genotypes of the test plants differs. The morphological differences could be seen in the leaf hairs and fine leaf hairs. Sodiq & Timur, (2009) found that biophysical factors such as morphology, plant color anatomy, plant height, flag leaf length and width, stem size, and smooth leaf surface affect the level of damage to a plant. The intensity of the attack on local rice genotypes can be seen in Figure 3.

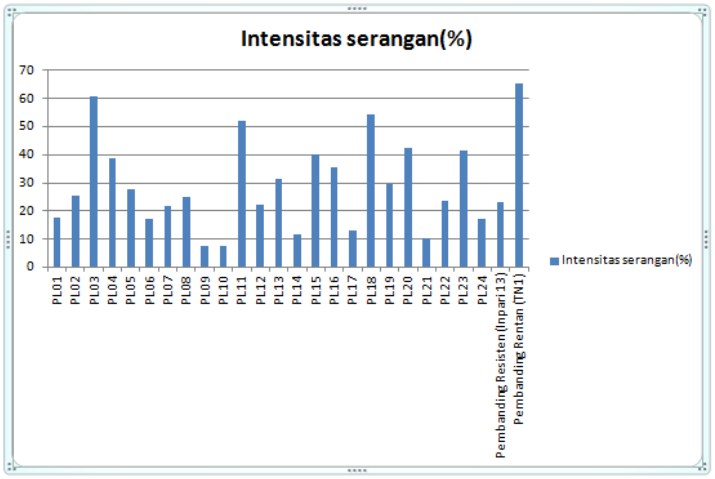

Figure 3. Histogram of the results of the attack intensity test

In addition to the intensity of the attack, the resistance of local rice genotypes in Kuantan Singingi Regency against brown planthopper pests could be seen in the leaves and plant growth. (IRRI, 2013)**,** states that the resistance criterion for the mode score is at 0. The line is said to be very resistant (ST) or highly resistant. If the score mode value is 1, the line is said to be resistant (T) or resistant. If the score mode value is 3, the line is said to be moderately resistant (AT) or moderately resistant. If the score mode value is 5, the line is said to be somewhat vulnerable (AR). If the score mode value is 7, the line is said to be susceptible (R). If the score mode value is 9, the line is said to be very vulnerable (SR).

The results showed that the level of resistance of the rice genotypes tested showed different responses. The genotypes were found with a score of 1, a score of 3, a score of 5, and a score of 9. The results also showed that of the twenty-four (24) local rice genotypes tested, there were twelve (12) genotypes that showed the resistant category, they were the Sironda Putih Rice genotype (PL01).), Red Singgaro Rice (PL06), Longevity Yellow Rice (PL07), Ros Rice (PL08), White Samo Rice (PL09), Limshadow Rice (PL10), Longevity Sokan Rice (PL12), White Singgam Rice (PL14), Pulut Benai (PL17), Yellow Rice (PL21), Gondok Rice (PL22) and White Katiok Rice (PL24). The results of the test scores for the resistance level of the rice genotype can be seen in Figure 4.

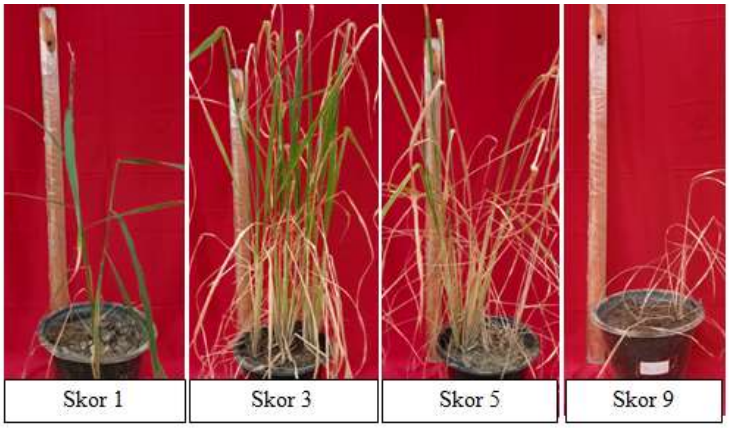

Figure 4. Score of local rice genotype resistance test results

Symptoms of attacks on rice plants caused by brown planthoppers could be seen directly starting on the stems that became brown, which over time caused the stems to dry out and eventually the plants die. This could be seen in plants with vulnerable and very vulnerable categories (score 9), such as the genotypes of Pandan Wangi Rice (PL03), Karate Pulut (PL11), Yellow Rice (PL18), Lupo Kalaki Pulut (PL20), and Yellow Saronda Rice (PL23).) and TN1 susceptible check varieties. This was due to a large amount of liquid in the plant that is sucked up by the brown planthopper. Sari & Yunus (2015)**,** pointed that brown planthoppers damaged rice plants by sucking the liquid from the stem cells of rice plants, so that plant growth is inhibited and, if the population is high, it can cause rice plants to dry out or look like they are burnt (hopperburn).

In general, plant resistance to insects was determined by three resistance mechanisms; antisenosis (physical and chemical), antibiosis, and tolerance. In this study, the resistance of local rice genotypes to brown planthoppers was tested based on a physical antisenosis mechanism, which is a resistance mechanism that occurs due to the structure or morphology of the plant as a barrier to eating and laying eggs. The difference in the resistance of local rice genotypes to brown planthoppers is due to a chemical antisenosis mechanism; rice plants contain allelochemical compounds that resist the presence of insect pests. Sodiq & Timur, (2009)**,** said that many types of plants contain chemical compounds that work as insect repellents. These chemical compounds generally consist of various kinds of alkaloids or other organic compounds.

Apart from the average damage score, the criteria for plant resistance can also be seen from the morphological appearance shown by all genotypes, that is the rather hard stems. Suryawan (2019)**,** in terms of morphology, resistant and moderately resistant varieties have hard stems and slightly rough leaf surfaces where the brown planthopper isn't fond of it. Hard stems and rough leaves are thought to make it difficult for the brown planthopper to stick a tool in its mouth to suck plant fluids and can also cause death in nymphs because they cannot eat.

(Sodiq & Timur (2009)**,** noted that there is a preference/non-preference resistance, or the liking or disliking of a plant by insects as a place to lay eggs, as shelter, as food, or a combination of the three. Insect preference for a host plant can be caused by physical stimulation (mechanical) and chemical properties present in the plant. Insect preference for mechanical stimuli originating from the plant's physical structure and surface properties. The structure and physical properties of the plant surface include, among others, skin thickness, the length, and thickness of hairs on the leaf surface, the size of stomata, and the thickness of the cuticle layer. The insect's preference for mechanics is closely related to the structure of the tools and the method of taking feed and laying eggs that it has. Chemical stimuli can be in the form of odor stimuli or flavors possessed by plants, including alkaloids, atheris oil, fats, and others.

Sari & Yunus, (2015)**,** stated that apart from scoring and morphological appearance, the determination of resistance criteria was also supported by the response shown by plants during the infestation process, where resistant plants had properties to resist attacks from brown planthoppers. According to Untung (2001), who stated that resistant varieties may have traits (resisting) that defeat the traits that attract pests.

3. CONCLUSION

The results showed that all of the tested genotypes were 100% attacked by brown planthoppers with different levels of

attack intensity. Based on the level of attack intensity, the genotypes were found to be mild, namely Sironda White Rice (PL01), Singgaro Red Rice (PL06), Longevity Yellow Rice (PL07), Ros Rice (PL08), White Samo Rice (PL09), Limshadow Rice (PL10), Sokan Longevity Rice (PL12), White Singgam Rice (PL14), Pulut Benai (PL17), Yellow Rice (PL21), Gondok Rice (PL22) and White Katiok Rice (PL24). The genotypes were categorized as Red Saronda Rice (PL02), Black Pulut (PL04), Ronda Putiah Rice (PL05), Benai Rice (PL13), Singgam Kuriak Rice (PL15), Curry Pulut (PL16), White Rice (PL19), Pulut Lupo Ka Laki (PL20) and Paddy Saronda Kuning (PL23). The heavy categories were the Pandan Wangi Rice (PL03), Pulut Karate (PL11), and Yellow Rice (PL18) genotypes. Based on SES IRRI 2013 found genotypes with resistant criteria, namely: White Sironda Rice (PL01), Singgaro Red Rice (PL06), Longevity Yellow Rice (PL07), Ros Rice (PL08), White Samo Rice (PL09), Limshadow Rice (PL10), Sokan Longevity Rice (PL12), White Singgam Rice (PL14), Pulut Benai (PL17), Yellow Rice (PL21), Gondok Rice (PL22) and White Katiok Rice (PL24).

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