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# Resistance Analysis of Red Upland Rice (*Oryza nivara* L) Against Blast Disease

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**ABSTRACT**

*Rice blast has been known as the main disease on paddy which has high severity leading to economic loss. Exploring rice resistance can be an effective way to improve productivity and prosperity toward this staple crop. This study aims to determine several local varieties which have potential for productions and resistances. This study used factorial randomized block design (RBD) consisting of 2 factors including plant spacing (25 x 25 cm; 25 x 30 cm; 25 x 40 cm); upland rice variety of MSP 17, Sigambiri Merah, Hamparan Perak, and Kambiri Lumat. The results of the study reveal that variety has a significant effect on disease intensity especially Sigambiri Merah but not on Kembiri Lumat. However, there is no significant effect of spacing on blast intensity except in grain weight. Conclusion of this research was the varieties (V) selection of red upland rice is the best strategy to improve rice resistance toward blast disease.*

## 1. INTRODUCTION

Rice is a staple food which its need has been constantly increasing annually along with the inclining Indonesian population. Nowadays, Indonesia's population has reached 270 million people with an average consumption of rice per capita per year of 124 Kg (Yama & Unteawati, 2022). The problem faced in meeting the current demand for rice is the increasing conversion of agricultural land to non-agricultural land, especially in intensive paddy fields (Pradana *et al*., 2013). Hence it is necessary to make efforts to cultivate upland rice known locally as "padi gogo". Upland rice is a type of dry land rice that is tolerant to drought and has certain resistance toward biotic and abiotic stress. This upland rice nutrition per 100 g consists of 7.5 g protein, 0.9 g fat, 77.6 g carbohydrates, 16 mg calcium, 163 mg phosphorus, 0.3 g iron, 0.21 vitamin B1 and anthocyanin. The content of anthocyanin could prevent various diseases, including cancer, cholesterol, and coronary heart disease (Indriyani *et al*., 2013).

Blast has been known as main rice disease in tropical countru particularly Indonesia. This disease is caused by *Pyricularia grisea*. Blast disease sporulation can increase at relative humidity above 93%, sporulation rarely occurs at humidity 89 – 90 % and sporulation will not occur at humidity less than 88% although the size of the spots is the same when the humidity is high (Varissa, 2021). Pathogen attack *P. grisea* can reach 1.28 ($10^6$) ha or about 12% of the total rice planting area in Indonesia (Santoso & Nasution, 2008). Intensity of pathogen attack of *P. grisea* can be seen in the young rice plants. Disease behavior is often associated with climatic factors in the field on the resistance of varieties and population of *P. oryzae* is strongly influenced by temperature (Spialena & Palupi, 2017). Therefore, warm temperature compromises basal resistance to increase M. oryzae infection by declininig JA transduction and synthesis (Qiu *et al.,* 2022).

Pathogenic fungus *P. grisea* able has high severity and could interfere with rice in both stages (vegetative and generative). In the vegetative stage of plants, the pathogen usually infects the leaves called leaf blast. In the generative stage, apart from infecting the leaves, it also infects the neck of the panicle and its pathogens can survive on field-infected rice scraps (Putri *et al.,* 2022). Upon the penetration prior infection, these pathogenic fungi form special structure called Appressorium leading to apoptosis mechanism on the infected surface lading to spore penetration (Eseola *et al.,* 2021). Pathogenic infection can also occur in the nodes of rice plants causing stem breakage and complete death of the scion of the infected nodes (Gong *et al*., 2020).

Controlling blast disease is usually executed in various ways including cultivation techniques, planting resistant varieties, and using fungicides. The use of resistant varieties is the most effective, economical and easy way to do it. However, the use of this technology deals with blast disease pathogens that have high genetic diversity and adaptability so that they quickly form new races that can break the resistance of newly introduced varieties (Lestari *et al*., 2011). However this approach is the best way to tackle the problem due to the effectivity could reach 75% (Shahriar *et al*., 2020). The reason for the formation of this dynamic population includes the ability to perform recombination both sexually and asexually. In this experiment we tried to analyze the resistance of a number of upland rice varieties to blast disease (*Pyricularia grisea*).

## 2. MATERIALS AND METHODS

### 2.1. Sample Collection

The materials used in the research were red rice seeds of several varieties, namely MSP 17, Sigambiri Merah, Hamparan Perak, and Kambiri Lumat which are local varieties from North Sumatra. The seed was collected from UPT Balai Benih Induk Padi, Medan.

### 2.2. Research Design

This research was conducted using a factorial randomized block design (RBD) consisting of 2 factors including plant spacing (25 x 25 cm; 25 x 30 cm; 25 x 40 cm); and upland rice variety including MSP 17, Sigambiri Merah, Hamparan Perak, and Kambiri Lumat with 4 replications for each of 12 treatment combinations. The seeds were planted in a plot by making 36 shipyard plots measuring 100 cm x 100 cm. After obtaining result in every parameter including: number of rice stem, seed weight, disease intensity. The results were analyzed with this following formula:

$$\boldsymbol{Y\,i\,j\,k} = \boldsymbol{\mu} + r\,\boldsymbol{i} + \alpha\boldsymbol{j} + \beta\boldsymbol{k} + (\alpha\beta)\boldsymbol{j\,k} + \sum\boldsymbol{i\,j\,k} \tag{1}$$

where *Yijk* is the results of observations on the $i^{th}$ repetition that received spacing treatment at the *j*-level and the red upland rice variety at the *k*-level; *r* is replication; $\boldsymbol{\mu}$ is mean; α*j* is effect of plant spacing and β*k* is effect of variety. The result were further analyzed using DNMRT analysis.

### 2.3. Result and discussion

The classification of severity level is shown in the Tabel 1.

Table 1. Classification level of rice resistance to blast disease according to IRRI (1996)

| Disease Severity (%) | Resistance Level |
|---|---|
| 0% | Very resistant |
| 1 - 5 % | Resistant |
| 6 - 12 % | Slightly resistant |
| 13 - 25 % | Moderate vulnerable |
| 26 - 50 % | Slightly vulnerable |
| 51 - 75 % | Vulnerable |
| 76 - 100% | Very vulnerable |

### 2.4. Planting

Land clearing and processing prior planting were carried out manually and mechanically in the experiment field by using minimum tillage method. Seed were directly planted using manual seeder without seedling. Then 36 plots were made with a size of 10 cm x 10 cm, while the spacing were set as follows: 25 cm x 20 cm; 25 cm x 30 cm and 25 cm x 40 cm. The distance between plots and replication was 50 cm. Fertilization on rice plants was carried out 4 times, namely before planting using TSP fertilizer at a dose of 75 kg/ha and KCL at a dose of 50 kg/ha, the second fertilization was carried out at the age of the plants 14 days after planting (DAP) using Urea fertilizer at a dose which has been determined is 200 kg/ha, the third fertilization is carried out at the age of the plant 42 DAP using Urea fertilizer at a dose of 300 kg/ha and the fourth fertilization is carried out at the age of the plant 55 DAP with Urea fertilizer at a dose of 200 kg/ha is carried out by digging and then covered again with soil to prevent loss of nutrients from the fertilizer used. Rice harvesting is done when most of the leaves have turned yellow and 80% of the grain is filled (75 – 80 DAP).

Observation was conducted to elucidate the intensity of leaf blast disease (leaf blast) and panicle neck blast taken intervals of once a week (4 – 18 weeks). The investigation was carried out by observing initial symptoms of blast disease on the leaf surface in every sample. Categories were grouped based on classification level of rice resistance to blast disease according to IRRI (1996).

Disease Intensity Blast infection intensity was calculated using this following formula:

$$IP = \frac{\sum(nv)}{NV} \times 100\% \quad (2)$$

where $nv$ is disease severity; $n$ is number of rice in every severity scale; and $v$ is severity value; $N$ is number of sample; and $V$ is the highest severity scale

## 3. RESULTS AND DISCUSSION

### 3.1. Number of Tillers

Data analysis on average of tiller number from 3 to 8 WAP is shown in Table 2 and then further analyzed by Duncan test (Table 3). Based on Table 2 on plant space on 8WAP J1 and J2 (25 x 20 cm; 20 x 30 cm) had significant effect on tiller number. It appears there is intention of increasing number tillers together with plant space in observed sample. These also appeared that sample variety has crucial role in regulating and supporting tiller number. Genome Wide analysis shows that there is association between tiller number of rice with genes regulation. Those genes were OsAAP1, DWL2, NAL1, and OsWRKY74 which belongs to Effective Tiller Number (ETN) associated QTL (Ren *et al*., 2021).

### 3.2. Blast Disease Intensity on Leaves (%)

Observational and analysis of variance of blast intensity were carried out at the age of 4 weeks after planting (WAP) to 18 weeks after planting Table 4. Based on Table 4, it could be seen the treatment of spacing (J) had no significant effect on plant age at 4 -11 WAP on the intensity of leaf blast disease only at age 5, 6, and 12 WAP. The treatment of variety (V) had a very significant effect on the intensity of leaf blast disease at the age of 4 to 18 WAP. However, the combination

Table 2. Summary of ANOVA test on number tillers

| SK | Number tiller on 3-8 WAP | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3 | | 4 | | 5 | | 6 | | 7 | | 8 | | F.05 | F.01 |
| J | 1.65 | tn | 0.12 | tn | 0.22 | tn | 3.21 | tn | 3.83 | * | 13.25 | ** | 3.44 | 5.72 |
| V | 2.44 | tn | 7.04 | ** | 22.87 | ** | 66.21 | ** | 133.43 | ** | 251.21 | ** | 3.05 | 4.82 |
| J x V | 1.76 | tn | 1.04 | tn | 2.02 | tn | 1.58 | tn | 0.13 | tn | 2.15 | tn | 2.55 | 3.76 |
| KK | 16.45% | | 15.10% | | 13.10% | | 11.74% | | 8.73% | | 6.70% | | | |

Note: tn = not significant, * = Significant level of 95%, ** = Significant level of 99%

Table 3. Duncan analysis on number tillers

| Treatment | Number of tillers on 3 – 8 WAP | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3 | | 4 | | 5 | | 6 | | 7 | | 8 | |
| J1 | 2.02 | tn | 5.27 | tn | 9.50 | tn | 15.62 | tn | 21.9 | b | 28.47 | bB |
| J2 | 2.02 | tn | 5.13 | tn | 9.67 | tn | 17.44 | tn | 24.17 | a | 32.75 | aA |
| J3 | 1.81 | tn | 5.15 | tn | 9.33 | tn | 15.85 | tn | 23.23 | a | 31.44 | aA |
| V1 | 1.88 | tn | 5.71 | aA | 11.57 | aA | 21.24 | aA | 30.21 | aA | 40.35 | aA |
| V2 | 1.74 | tn | 4.25 | bB | 7.26 | bB | 11.59 | bB | 16.59 | bB | 21.73 | bB |
| V3 | 2.08 | tn | 5.69 | aA | 10.71 | aA | 20.33 | aA | 29.43 | aA | 40.52 | aA |
| V4 | 2.09 | tn | 5.07 | aA | 8.47 | aA | 12.05 | bB | 16.17 | bB | 20.94 | bB |
| J1V1 | 1.73 | tn | 5.80 | tn | 11.87 | tn | 8.83 | tn | 30.53 | tn | 37.13 | tn |
| J1V2 | 2.07 | tn | 4.00 | tn | 6.87 | tn | 5.43 | tn | 16.53 | tn | 20.27 | tn |
| J1V3 | 2.00 | tn | 5.40 | tn | 9.53 | tn | 7.47 | tn | 24.87 | tn | 36.73 | tn |
| J1V4 | 2.27 | tn | 5.87 | tn | 9.73 | tn | 7.80 | tn | 15.67 | tn | 19.73 | tn |
| J2V1 | 1.92 | tn | 5.75 | tn | 11.25 | tn | 8.50 | tn | 30.42 | tn | 44.08 | tn |
| J2V2 | 1.75 | tn | 4.50 | tn | 8.33 | tn | 6.42 | tn | 17.08 | tn | 22.50 | tn |
| J2V3 | 2.42 | tn | 5.75 | tn | 11.17 | tn | 8.46 | tn | 32.50 | tn | 43.83 | tn |
| J2V4 | 2.00 | tn | 4.50 | tn | 7.92 | tn | 6.21 | tn | 16.67 | tn | 20.58 | tn |
| J3V1 | 2.00 | tn | 5.58 | tn | 11.58 | tn | 8.58 | tn | 29.67 | tn | 39.83 | tn |
| J3V2 | 1.42 | tn | 4.25 | tn | 6.58 | tn | 5.42 | tn | 16.17 | tn | 22.42 | tn |
| J3V3 | 1.83 | tn | 5.92 | tn | 11.42 | tn | 8.67 | tn | 30.92 | tn | 41.00 | tn |
| J3V4 | 2.00 | tn | 4.83 | tn | 7.75 | tn | 6.29 | tn | 16.17 | tn | 22.50 | tn |

Note: Numbers followed by the same letter in the same column are not significantly different according to DMRT at α.= 5% (lowercase) and α.= 1% (uppercase).

Table 4. Disease intensity (%) from 4 – 18 WAP

| | | Variation source | | | |
|---|---|---|---|---|---|
| | | J | V | J x V | CV |
| Blast disease intensity on leaves 4-18 WAP | 4 | 1.29tn | 6.32** | 0.59tn | 60.41% |
| | 5 | 4.36* | 7.68** | 1.84tn | 47.56% |
| | 6 | 5.17* | 19.48** | 3.41* | 35.50% |
| | 7 | 0.2tn | 37.81** | 0.39tn | 23.87% |
| | 8 | 12.28** | 225.23** | 10.17** | 25.80% |
| | 9 | 10.25** | 301.68** | 5.23** | 21.89% |
| | 10 | 9.53** | 349.07** | 4.82** | 21.13% |
| | 11 | 2.12tn | 300.56** | 1.53tn | 23.16% |
| | 12 | 3.93* | 395.57** | 2.45tn | 19.20% |
| | 13 | 15.61** | 684.97** | 6.14** | 15.42% |
| | 14 | 11.33** | 754.86** | 1.35tn | 13.40% |
| | 15 | 21.74** | 1299.91** | 1.33tn | 10.03% |
| | 16 | 37.79** | 3396.71** | 4.88** | 6.07% |
| | 17 | 13.51** | 891.12** | 0.55tn | 11.11% |
| | 18 | 16.44** | 1002.95** | 2.3tn | 10.03% |
| **F.05** | | 3.44 | **3.05** | **2.55** | |
| **F.01** | | 5.72 | **4.82** | **3.76** | |

Note: Numbers followed by the same letter in the same column are not significantly different according to DMRT at α.= 5% (lowercase) and α.= 1% (uppercase).

Table 5. Duncan test for disease intensity on leaves

| Treatment | Week After Planting (WAP) | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 |
| **J1** | 1.26tn | 1.67a | 2.49a | 3.01tn | 7.63aA | 5.78aA | 6.53aA | 6.64tn | 7.4a | 9.27aA | 8.74aA | 8.9aA | 9.98aA | 9.88aA | 9.92aA |
| **J2** | 0.89tn | 1.05a | 1.74b | 3.2tn | 6.19aA | 6.66aA | 7.22aA | 7.09tn | 7.29a | 7.84aA | 6.84bB | 6.78bB | 8.23aA | 8.14aA | 8.67aA |
| **J3** | 1.31tn | 1.91b | 2.81a | 3.08tn | 4.48bB | 4.41bB | 4.93bB | 5.84tn | 6.03b | 6.5bB | 6.75bB | 6.95bB | 7.99bB | 7.66bB | 7.55bB |
| **V1** | 0.34bB | 0.54bB | 0.58aA | 1.43aA | 1.78bB | 1.83aA | 1.96bB | 2.25bB | 2.73aA | 2.81aB | | | | | |
| **V2** | 1.41aA | 2.01aA | 2.75bB | 3.07bB | 2.22aA | 1.97aB | 1.97bB | 1.82bB | 2.11bB | 2.21bB | 2.74bB | 3.06bB | 3.74bB | 4.05bB | 4.6bB |
| **V3** | 1.17aA | 1.73aA | 3.4aA | 5.1aA | 17.76aA | 16.29bB | 18.52aA | 19.61aA | 20.1aA | 23.75aA | 23.99aA | 24.07aA | 27.52aA | 25.98aA | 25.84aA |
| **V4** | 1.7aA | 1.91aA | 2.67aA | 2.79aA | 2.64aA | 2.38bB | 2.47bB | 2.41bB | 2.71aA | 2.71aB | 3.04bB | 3.05bB | 3.68bB | 4.21bB | 4.43bB |
| **J1V1** | 0.39tn | 0.35tn | 0.57a | 1.19tn | 1.47bB | 1.18bB | 1.21bB | 1.21tn | 1.99tn | 3.03aA | | | | | |
| **J1V2** | 1.37tn | 2.67tn | 3.41a | 3.14tn | 2.31aA | 2.02aA | 2.15aA | 1.79tn | 2.13tn | 2.68aA | 3.89tn | 4.49tn | 5.1aA | 5.33tn | 5.49tn |
| **J1V3** | 1.53tn | 1.54tn | 3.19a | 4.83tn | 23.68aA | 17.01aA | 19.77aA | 20.99tn | 22.19tn | 27.79aA | 26.9tn | 26.69tn | 30.07aA | 28.73tn | 28.02tn |
| **J1V4** | 1.75tn | 2.13tn | 2.8a | 2.87tn | 3.04aA | 2.9aA | 2.96aA | 2.57tn | 3.27tn | 3.57aA | 4.15tn | 4.42tn | 4.77aA | 5.45tn | 6.15tn |
| **J2V1** | 0.32tn | 0.2tn | 0.73a | 1.71tn | 2.53aA | 3.09aA | 3.48aA | 3.98tn | 4.23tn | 3.66aA | | | | | |
| **J2V2** | 0.83tn | 1.25tn | 1.96a | 2.93tn | 2.48aA | 2.19aA | 2.07aA | 1.88tn | 2.13tn | 2.07aA | 2.23tn | 2.39tn | 2.63bB | 3.32tn | 4.18tn |
| **J2V3** | 0.83tn | 0.83tn | 1.78a | 5.53tn | 17.54aA | 19.28aA | 21.16aA | 20.1tn | 20.21tn | 23.41aA | 22.71tn | 22.33tn | 27.02aA | 25.35tn | 26.42tn |
| **J2V4** | 1.61tn | 1.93tn | 2.49a | 2.63tn | 2.19aA | 2.09aA | 2.18aA | 2.39tn | 2.62tn | 2.23aA | 2.44tn | 2.42tn | 3.29aA | 3.91tn | 4.07tn |
| **J3V1** | 0.32tn | 1.08tn | 0.43b | 1.38tn | 1.33bB | 1.23bB | 1.18bB | 1.56tn | 1.97tn | 1.73bB | | | | | |
| **J3V2** | 2.03tn | 2.11tn | 2.88a | 3.16tn | 1.87aA | 1.68aA | 1.68aA | 1.78tn | 2.06tn | 1.89aA | 2.09tn | 2.29tn | 3.51aA | 3.5tn | 4.11tn |
| **J3V3** | 1.15tn | 2.81tn | 5.22a | 4.93tn | 12.06aA | 12.58aA | 14.62aA | 17.74tn | 17.88tn | 20.06aA | 22.38tn | 23.18tn | 25.48aA | 23.88tn | 23.05tn |
| **J3V4** | 1.76tn | 1.67tn | 2.71a | 2.87tn | 2.68aA | 2.14aA | 2.26aA | 2.27tn | 2.23tn | 2.31aA | 2.53tn | 2.32tn | 2.97aA | 3.27tn | 3.06tn |

Note: Numbers followed by the same letter in the same column are not significantly different according to DMRT at α.= 5% (lowercase) and α.= 1%


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of treatment between spacing (J) and variety (V) had no significant effect on the intensity of leaf blast disease of red upland rice at 4, 5, 7, 12, 14, 15, 17 and 18 WAP. The interaction affected significantly on intensity at 8, 9, 10, 13, and 16 WAP.

The results of this study spacing, annotation of "V", is suggested to be increase in red upland rice cultivation decreases the rate of spread of blast disease spores on leaves. The denser the spacing used, the faster the spread of spores that take place on plant leaves. Number of populations will create environmental conditions, especially temperature, humidity and aeration, which is favorable for plant diseases development, especially blast disease. There should be effective spacing for every crop considering rooting, light intensity and disease spreading (Onyango, 2016). *P. grisea* will facilitate the occurrence of infection and transmission from one plant to another. Fungal conidia were released on the leaves and panicles of plants starting in the early hours of the morning 02.00 to 06.00 Am, especially in wind season triggering fungal conidia to spread faster. Hence, they can spread spores and conidia to all parts of the plant leaf that are in contact with infected leaves. The number of spores attached to the leaves depends on the wind speed and the angular position of the leaves. The greater the angle of the leaf, the more spores spread to the leaf. In another case, due to the fact of this spreading, wheat blast is considered an intractable and dangerous disease and fungicides have shown limited efficacy (Cruz & Valent, 2017). Duncan test was then performed for further analysis which is shown in Table 5.

Based on Table 5 every particular plant spacing and plant variety has significant effect on disease intensity but not in interaction for several observed weeks. On the average variety treatment (V) it can be seen it had a very significant effect on the intensity of leaf blast disease in upland brown rice. When plants aged 13 WAP the V3 treatment (Hamparan Perak) is higher from the V1 treatment (17 WAP and V4 (Kambiri Lumat) and very significantly different from the V2 treatment (Sigambiri Merah). Blast attack on shown in Figure 1.

Blast attacks on the leaves of rice plants also affected all varieties used, both blast-resistant varieties which can be seen in Appendix 1 for the description of the varieties used, although the percentage of attacks that occurred was not as high as that of Hamparan Perak (V3). Planting high-yielding blast-resistant varieties proved to be effective in a single cropping area, but their resistance was only able to last 2-4 seasons (Nasution, 2015). This shows that fungus-causing blast disease easily forms new races with a high level of virulence so that they can quickly break the resistance of a variety to blast disease (Shahriar *et al*., 2020). Gene annotation investigation successfully identified 58 to 78 MAX effector genes per genome in a set of 120 isolates representing seven host-associated lineages leading to restriction of early biotrophic infection and strongly influenced by the host plant (Naour—Vernet *et al.,* 2023). NMR observation

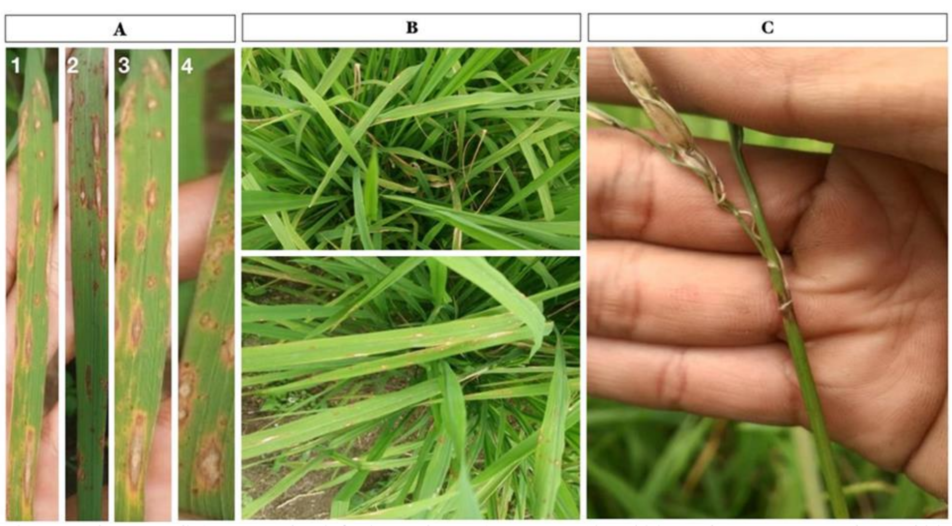


**Figure 1.** Blast on upland rice: A) Blast infection on leaves; (1. WAP 17, Sigambiri Merah, Hamparan Perak, Kambiri Lumat); B) Blast infection on paddy stem; C) Blast infection on panicle

shown that MAX effectors superfamily in 20 structural groups that vary in the canonical MAX fold, disulfide bond patterns, and additional secondary structures in N- and C-terminal extensions which potentially effecting the wide diversity of their virulence functions and host targets (Cadiou, *et al.,* 2023; Lahfa *et al.,* 2023).

High rainfall and humidity are triggering factors of disease outbreak *P. grisea* (Arifin, 2014). The lower the temperature and the higher the humidity and the higher the rainfall can affect the high rate of blast disease infection (Nasution & Usyati, 2015). Humidity, temperature and excessive rainfall either in the form of rain, dew or humidity are factors that really help the disease develop.

The dominant pathogenic race in an area is easy to change and will determine the level of resistance of a variety planted in that region. As a result, the use of resistant varieties is not only limited by time but also by the place and environmental conditions that support the development of new pathogenic races in a particular area. Varieties that were previously resistant to blast disease in one place may become susceptible after being planted in a new place or in another place (Yulianto, 2015). The treatment of variety (V) had a very significant effect on the intensity of leaf blast disease at the age of 4 to 18 WAP. The combination of treatments between spacing (J) and variety (V) had no significant effect on the intensity of leaf blast disease of red upland rice throughout the assessment period, but significantly affected the intensity of leaf blast attack at 6 WAP.

### 3.3. Intensity of Blast in Rice on Panicle (%)

Observation data and analysis of variance of panicle blast intensity at 11 weeks after planting (WAP) to 18 weeks after planting (WAP) are shown in Table 6. The average intensity of panicle blast was 11 to 18 weeks after planting. Table 6 shows that the spacing treatment (J) had no significant effect on plant age 11 to 18 WAP on blast intensity in the panicles of red upland rice plants. The treatment of variety (V) had a significant effect on the age of the plant at 15 WAP and had a very significant effect on the intensity of panicle blast attack on red upland rice plants at the age of 11, 12, 13, 14, 16, 17, and 18 WAP this also shown by the Duncan's test (Table 7).

On the average treatment of several varieties (V) in Table 7, when the plant was 18 WAP it was seen that the Hamparan Perak (V3) variety had a very significant effect on the V2 (Sigambiri Merah) and V4 (Kambiri Lumat) treatments with the highest average value V3, namely 27.59%. because at the age of 13 WAP V1 the plants had already been harvested so that at the ages of 14 to 18 WAP there was no average value of panicle blast attack. The results obtained in this study indicate that panicle blast disease is caused by a fungus *Pyricularia grisea* very dominant in attacking the Hamparan Perak because each plant variety has a different response to blast attack. Genetic factors and morphological differences have a major influence on the resistance of rice leaves and panicles to blast disease, especially on the phenotypic appearance (Kharisma *et al*., 2013). Research results obtained show that the fungus that causes blast disease easily forms new races with a high level of virulence so that they quickly break the resistance of certain varieties (Yulianto, 2017).

### 3.4. Grain weight per 1000 grains (g)

Average analysis of variance of grain production weight per 1000 grains on plant is presented in Table 8. The spacing treatment (J) had a very significant effect on the weight of plant production per sample of red upland rice. Treatment J3

Table 6. Summary of the results of the analysis of variance of Blast intensity on Panicle

| SK | Blast intensity on 4-18 WAP | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | F.05 | F.01 |
| J | 0.21tn | 0.56tn | 0.25tn | 2.18tn | 2.86tn | 0.72tn | 0.47tn | 0.16tn | 3.44 | 5.72 |
| V | 11.57** | 24.05** | 34.12** | 7.32** | 3.39* | 28.5** | 88.23** | 155.26** | 3.05 | 4.82 |
| J x V | 1.16tn | 0.68tn | 0.73tn | 1.57tn | 0.86tn | 0.9tn | 1.18tn | 0.23tn | 2.55 | 3.76 |
| CV | 63.48% | 40.83% | 34.51% | 36.92% | 25.45% | 14.74% | 11.76% | 11.20% | | |

Note: tn = not significant, * = significant 95%, ** = significant 99%, WAP = Week After Planting

Table 7. Duncan's test on blast intensity analysis on rice panicle

| Treatment | Blast in Rice Panicle (WAP) | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 11 | | 12 | | 13 | | 14 | | 15 | | 16 | | 17 | | 18 | |
| **J1** | 8,83 | tn | 10,7 | tn | 11,2 | tn | 10,2 | tn | 11,3 | tn | 11,7 | tn | 12,6 | tn | 13,7 | tn |
| **J2** | 7,54 | tn | 8,94 | tn | 10,3 | tn | 10,7 | tn | 8,65 | tn | 10,8 | tn | 11,9 | tn | 13,4 | tn |
| **J3** | 7,84 | tn | 9,91 | tn | 11,2 | tn | 14,1 | tn | 11,1 | tn | 11,3 | tn | 12,1 | tn | 13,3 | tn |
| **V1** | 13,4 | aA | 13,6 | aA | 15,8 | aA | | | | | | | | | | |
| **V2** | 8,07 | aA | 13 | aA | 13,5 | aA | 14,5 | aA | 14,2 | a | 13,5 | aA | 13,1 | bB | 13,5 | bB |
| **V3** | 0 | bB | 0 | bB | 0 | bB | 7,23 | bB | 15,8 | a | 19,5 | aA | 23,2 | aA | 27,6 | aA |
| **V4** | 10,8 | aA | 12,8 | aA | 14,3 | aA | 13,3 | aA | 11,5 | b | 12,1 | bB | 12,5 | bB | 12,8 | bB |
| **J1V1** | 11,6 | tn | 13,2 | tn | 15,4 | tn | | | | | | | | | | |
| **J1V2** | 6,83 | tn | 12,7 | tn | 14,7 | tn | 3,14 | tn | 14,6 | tn | 14,1 | tn | 13 | tn | 5,33 | tn |
| **J1V3** | 0 | tn | 0 | tn | 0 | tn | 4,83 | tn | 18,9 | tn | 21,3 | tn | 24,8 | tn | 28,7 | tn |
| **J1V4** | 16,9 | tn | 16,7 | tn | 14,9 | tn | 2,87 | tn | 11,8 | tn | 11,6 | tn | 12,3 | tn | 5,45 | tn |
| **J2V1** | 14,1 | tn | 13,8 | tn | 16,2 | tn | | | | | | | | | | |
| **J2V2** | 8,89 | tn | 11,9 | tn | 9,91 | tn | 9,51 | tn | 12,2 | tn | 12,2 | tn | 12,1 | tn | 3,32 | tn |
| **J2V3** | 0 | tn | 0 | tn | 0 | tn | 9,17 | tn | 11,3 | tn | 18,3 | tn | 22,6 | tn | 25,4 | tn |
| **J2V4** | 7,22 | tn | 10,1 | tn | 15 | tn | 13,5 | tn | 11 | tn | 12,7 | tn | 12,9 | tn | 3,91 | tn |
| **J3V1** | 14,7 | tn | 13,8 | tn | 15,8 | tn | | | | | | | | | | |
| **J3V2** | 8,48 | tn | 14,3 | tn | 16 | tn | 19,2 | tn | 15,7 | tn | 14,3 | tn | 14,2 | tn | 3,5 | tn |
| **J3V3** | 0 | tn | 0 | tn | 0 | tn | 8,19 | tn | 17,1 | tn | 18,9 | tn | 22 | tn | 23,9 | tn |
| **J3V4** | 8,2 | tn | 11,6 | tn | 13,1 | tn | 14,8 | tn | 11,7 | tn | 11,8 | tn | 12,2 | tn | 3,27 | tn |

Note: Numbers followed by the same letter in the same column are not significantly different at the level α.0.5 (lowercase) and α.0.1 (uppercase) based on Duncan's test

Table 8. Summary of ANOVA test on weight of grain production per 1000 grains (g)

| SK | Grain Weight | F.05 | F.01 |
|---|---|---|---|
| **J** | 34,72 | 3,44 | 5,72 |
| **V** | 65,67 | 3,05 | 4,82 |
| **J ×V** | 1,59 | 2,55 | 3,76 |
| **KK** | 6,45% | | |

Note: tn = not significant, * = Significant level of 95%, ** = Significant level of 99%

(25 × 40) had a very significant effect on treatments J2 (25 × 30) and J1 (25 × 20) with the largest weight of 29.08 grams, while the lowest was treatment J2 with a weight value of 24.06 grams. The results of this study are thought to be due to several supporting factors for plant growth such as the number of seeds planted per planting hole and the spacing used. planting holes, if there is too much seed given, it will lead to competition for nutrients and space for plant development because the root space is narrower, resulting in stunted growth and low production yields from rice plants. Proper spacing can give high yields, because there is a distribution of nutrients and sunlight, the number of tillers is in the most favorable conditions, fertilization and grains of rice plants can mature evenly.

In the treatment factors of several varieties (V) it can be seen that factor V has a significant effect on the weight of plant production per sample (g) of red upland rice. Treatment V1 (MSP 17) had a very significant effect on treatment V3 (Overlay Silver) with an average value of plant production weight per sample of 30.23 grams, but not significantly different in treatments V2 (Sigambiri Merah) and V4 (Kambiri Lumat) both at the 95% and 99% confidence with each value of V2 which is 26.69 grams and V4 which is 27.17 grams while the lowest weighted average value is found in V3 which is 19.56 grams. The research results obtained were allegedly due to the use of the MSP 17 variety which was included in the superior varieties which were varieties that had disease resistance and had optimal growth during the research.

Table 9 shows Hamparan Perak variety, which was dominantly attacked by leaf blast and panicle blast disease, resulted in a very high yield loss from the J1V3 treatment. Panicle neck blast disease in susceptible varieties can result in yield losses of up to 100%. Under favorable environmental conditions, rice varieties that are severely infected with a high level of intensity, both by leaf blast disease and panicle neck blast disease, can cause puso plants. Therefore it is strongly suspected that the Hamparan Perak variety used produced the lowest grain weight due to the high attack of leaf blast disease and panicle blast disease.

Table 8. Duncan's analysis on grain weight per 1000 grains

| Treatment | Grain Weight (g) | |
|---|---|---|
| J1 | 28,08 | tn |
| J2 | 28,00 | tn |
| J3 | 27,25 | tn |
| V1 | 27,78 | aA |
| V2 | 29,00 | aA |
| V3 | 26,22 | bB |
| V4 | 28,11 | aA |
| J1V1 | 28,00 | tn |
| J1V2 | 29,00 | tn |
| J1V3 | 26,67 | tn |
| J1V4 | 28,67 | tn |
| J2V1 | 27,33 | tn |
| J2V2 | 30,00 | tn |
| J2V3 | 26,33 | tn |
| J2V4 | 28,33 | tn |
| J3V1 | 28,00 | tn |
| J3V2 | 28,00 | tn |
| J3V3 | 25,67 | tn |
| J3V4 | 27,33 | tn |

Where: Numbers followed by the same letter in the same column are not significantly different at the level α.0.5 (lowercase) and α.0.1 (uppercase) based on Duncan's test

### 3.5. Grain Weight

Average grain production weight in plot is presented in Table 10 and Duncan test is shown in Table 11. Summary of the results of the analysis of variance in the weight of grain production per plot (g) for red upland rice varieties (V) and plant spacing (J). From the data in Table 6 it can be seen that the spacing treatment (J) did not significantly affect the weight of plant production per plot, while the variety treatment factor (V) had a very significant effect on the weight of plant production per plot, but in the treatment combination spacing (J) and variety (V) had no significant effect on the weight of plant production per plot.

On the average treatment of several varieties (V) it can be seen that the V3 (Overlay of Silver) treatment had a very significant effect on the V2 treatment (Sigambiri Merah), namely 21.73 and the V4 treatment (Kambiri Lumat), namely 20.94 with the highest average number of tillers , namely 40. 52 but not significantly different from treatment V1 (MSP 17) at a confidence level of 95% or 99% with the number of tillers, namely 40.35. The difference in the number of tillers that occur in each variety cultivated in this research is because in this study several local varieties and superior varieties were used. The difference in the number of tillers produced by each cultivar is caused by the ability of each cultivar to produce different tillers (Yongki, 2009).

Table 9 provides a summary of the results of the analysis of the weight of variance of grain production per plot(g) on red upland rice varieties (V) and planting spacing (J). In addition, Table 11

Table 10. Summary of ANOVA of grain production per plot(g)

| SK | Weight per plot | | F.05 | F.01 |
|---|---|---|---|---|
| **J** | 2,55 | tn | 3,44 | 5,72 |
| **V** | 13,43 | ** | 3,05 | 4,82 |
| **J ×V** | 1,41 | tn | 2,55 | 3,76 |
| **KK** | 16,77 | | | |

Where: tn = not significant, * = Significant level of 95%, ** = Significant level of 99%

Table 10. Duncan Analysis of the weight of grain production per plot (g) on red upland rice varieties (V) and planting spacing (J)

| Treatment | Average yield g) | Significance |
|---|---|---|
| J1 | 203,67 | tn |
| J2 | 240,92 | tn |
| J3 | 228,92 | tn |
| V1 | 298,11 | aA |
| V2 | 197,33 | bB |
| V3 | 187,44 | bB |
| V4 | 215,11 | aA |
| J1V1 | 245,33 | tn |
| J1V2 | 204,67 | tn |
| J1V3 | 182,67 | tn |
| J1V4 | 182,00 | tn |
| J2V1 | 319,00 | tn |
| J2V2 | 202,67 | tn |
| J2V3 | 183,33 | tn |
| J2V4 | 258,67 | tn |
| J3V1 | 330,00 | tn |
| J3V2 | 184,67 | tn |
| J3V3 | 196,33 | tn |
| J3V4 | 204,67 | tn |

Note: Numbers followed by the same letter in the same column are not significantly different according to DMRT at α.= α.= 5% (lowercase) and α.= 1% based on Duncan's test

## 4. CONCLUSIONS

The use of treatment factors of several spacings (J) has a very significant effect on plant vegetative growth, namely the results of observing the number of tillers, the intensity of leaf blast disease and plant production weight per sample (g). The use of treatment factors for several varieties (V) of red upland rice plants had a very significant effect on the number of tillers, the intensity of leaf blast disease, attack intensity panicle blast disease, weight of grain production per sample plant (g), weight of grain production per plot (g) and weight per 1000 grain grains (g). The combination treatment of several spacing (J) and several varieties (V) of red upland rice had a very significant effect on the intensity of leaf blast disease (%).

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