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Identification of Dryland Local Rice Varieties and Their Advantages Based on Agronomic Characters

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Abstract. The information on rice genetic material is needed to create new high-yielding varieties adaptive to dryland. Local rice genetic resources have been tested to be tolerant under conditions affected by global climate change (increased temperature, pest/disease attacks, droughts). This study aims to identify and characterize the agronomic character of local rice in Musi Rawas (MURA) and North MURA Regencies, South Sumatra. The results of identification and characterization, as well as correlation and regression analysis, revealed that three local varieties have agronomic characteristics that determine high-yield local rice productivity. This information can be utilized by breeders to create new superior varieties of rice in dryland. The agronomic characteristics of three local rice varieties that determine productivity are the area of the flag leaf and the number of filled grain/panicles. Local varieties with superior agronomic characteristics are Siam, Bolouh, and Gel. These three varieties have the potential to be used as parents in the creation of new high-yielding varieties that are specific, namely having broad flag leaves and a high number of filled grains/panicles. The acquisition of new high-yielding varieties specific to dryland through a breeding program will increase the choice of varieties for stakeholders and support increased rice production in dryland.

1 Introduction

Rice is one of the most important staple foods in the world [1, 2]. The world's food needs, including Indonesia, will increase due to population growth and increased consumption. In 2045, the projected population of Indonesia will reach 319 million people [3] With consumption reaching 99.5 kilograms per capita, 41.7 million tons of rice will be needed in 2045 [4]. The increase in demand must be accompanied by an increase in rice production. One of the potential sources of rice production to support this effort is dryland.

Indonesia's dryland potential reaches 144.47 million ha, spread over Kalimantan (± 41.61 million ha), Sumatra (± 33.25 million ha), Papua (± 28.60 million ha), Sulawesi (±

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16.57 million ha), followed by Java, Maluku and Bali and Nusa Tenggara ± 10.27 million ha, ± 7.45 million ha, and ± 6.70 million ha, respectively [5]. Dryland in the lowlands covers the dominant area, about 111.33 million ha or 77.06% of the total dryland area. The rest is in the highlands, around 33.14 million ha. Sumatra has the second largest lowland dryland (22.83 million ha) after Kalimantan (40.04 million ha).

The area of dry-lowland acid wetland in Sumatra reaches 21.43 million ha. South Sumatra occupies the largest position in this area, namely 4,373 million ha. Various obstacles in rice farming are faced in this agroecosystem, especially if it is accompanied by global climate change. These constraints include low soil pH and fertility, floods, droughts, and attacks by pests and diseases.

The short-term effort to overcome these constraints is using tolerant new high-yielding varieties (NYV). These varieties produced by the Indonesian Agricultural Agency Research and Development (Balitbangtan) are now available to farmers and other stakeholders. The long-term effort that can be made is by creating tolerant NHYVs based on local varieties as donor genes. This study aims to identify and characterize the agronomic character advantages of local rice in MURA and North MURA, South Sumatra, and the opportunities for its use as donor genes in plant breeding programs.

2 Methodology

The activity was conducted in Musi Rawas Regency (MURA) and North MURA Regency (Muratara) from March-May 2021. Identification of quantitative characters observed was flag leaf area, productive tiller, panicle length, filled grain number/panicles, empty grain number/panicles, 1,000 grain weight, and filled grain weight/clumps.

Characterization of agronomic character, yield components and yields per individual plant refers to the Guide to the Rice Plant Characterization and Evaluation System **[6]**. The flag leaf area is estimated based on the formula Leaf area = 0.725 x leaf length x leaf width **[7].** The close relationship and the form of the relationship between flag leaf area and yield components with seed/clumps weight were tested through correlation and regression analysis.

3 Results and discussion

3.1 Quantitative character of local rice

Characterization was carried out to determine the nature of each local variety. The quantitative characters observed were flag leaf area, yield and yield components (Table 1). In general, there are variations in the character of the yield components. The number of productive tillers ranged from 17-22 tillers, three of which had >22 seedlings (24 tillers), namely Tambun rice, Jambe rice and Biji Duku rice.

Flag leaf area ranges from 30.88-76.80 cm^2, two local varieties with flag leaf area >80 cm, namely Boulouh rice and Siem rice. The panicle length ranged from 27.70-31.00 cm. The number of grain contents/panicles is around 154.00-298.33 grains. One local variety has the number of grain content/panicle >400 grains, namely Siem rice. All local varieties have empty grain/panicle <1 grain.

The weight of 1,000 grains is about 20-23 g. There is one variety with a weight of 1,000 grains of 25 g, namely Siem rice. The weight of the filled grain/clump is about 88-190 g. One local variety has a weight of grain content/clump >200 g, namely Siem Rice. Bolouh rice is the same as Siem rice except for the 1,000-grain weight character.

The identification results (Table 1) show that Siem rice is superior to other local varieties, followed by Bolouh rice. The advantages of Siem rice are in character, flag leaf area, panicle length, number of filled grain/panicle, weight of 1,000 grains and weight of filled grain/clump.

In the creating of new high-yielding variety, one of the important genes desired from the parents is the number of grain content/panicle >250 grains [8]. The results of this identification indicate that the total grain content/panicle of Siem rice is > 400 grains. Thus, Siem rice is one of the local rice that has the potential as a gene donor in the creation of new high yielding varieties (NHYV) and can be developed in suboptimal dryland.

Utilization of NHYVs whose gene sources come from local varieties will be able to adapt, produce high and stable in a vulnerable environment or in other agroecosystems affected by global climate change, such as salinity, high temperature, and water stress [9, 10]. Siem's local rice has been cultivated for generations on dryland. This shows that Siem rice is adaptive to drought stress conditions.

Table 1. Characterization of local rice yield components in MURA and North MURA Regencies, South Sumatra

Local Rice	**Productive tiller/ clumps (tiller)**	**Flag leaf area (cm^2)**	**Panicle length (cm)**	**Filled grain number/ panicles (grain)**	**Empty grain number/ panicles (grain)**	**1000 grain weight (g)**	**Filled grain weight/ clumps (g)**
Bolouh Rice (MURA)	19.00	86.03	30.33	428.00	0.39	21.00	190.00
Tambun Rice (MURA)	24.0	61.48	31.00	298.33	0.26	22.00	160.00
Gel Rice (MURA)	17.00	76.80	27.67	295.00	0.25	23.00	136.00
Siem Rice (MURA)	18.00	97.03	31.33	493.67	0.31	25.00	240.00
Jambe Rice (Muratara)	24.00	57.15	24.00	266.33	0.66	20.00	128.00
Kuning Rice (Muratara)	22.00	50.23	27.00	201.00	0.27	20.00	88.73
Biji Duku Rice (Muratara)	24.00	30.88	22.17	154.00	0.27	23.00	88.00

3.2 Correlation and Regression Agronomic Character with Local Rice Yields

The genetic superiority of local rice varieties from the agronomic aspect is one of the main outputs needed in the assembly of new high-yielding varieties of rice. Local varieties identified as having superior specific agronomic characters can be used as parents (gene donors) in the creation of superior varieties. Identification of the superiority of agronomic characters was carried out through correlation analysis (Table 2) and regression (Table 3), mainly through flag leaf area and yield components.

Seed weight/clump is one indicator of productivity. Table 2 shows that local rice agronomic characters that have a positive correlation with seed weight/clump are flag leaf area (r = 0.906**), number of grain content/panicle (r = 0.980**), and panicle length (r = 0.797*), weight of 1000 grains (r = 0.534), and the number of empty grains/panicles (r = 0.029). Meanwhile, the character that had a negative correlation with seed weight/clump was the number of productive tillers.

The results of this study are in line with the results of previous studies which showed that there was a close relationship between rice productivity with flag leaf area [11], flag leaf width [12], flag leaf length [13], number of filled grain/panicle [14], and panicle length (15, 16]. Flag leaves in rice play an important role in panicle development [13] as well as assimilate synthesis and translocation of assimilating to seeds [17]. Similar findings indicate that the flag leaf area plays an important role in increasing dry matter production and grain yield [18]. The broad flag leaves will increase the photosynthetic ability. Thus, it will increase the length of the panicle and increase the synthesis and translocation of assimilating to the seed thereby increasing grain yield.

Further tests on characters that were positively correlated with seed weight/clump were carried out through regression analysis (Table 3). The results of the regression analysis showed that the agronomic characters had highly significant regression with the weight of seeds/clumps being the area of the flag leaf and the number of filled grain/panicle (significance 0.05). The agronomic characters that had no significant regression with the weight of filled grain/clump were the number of productive tillers, the number of empty grains/panicles and the weight of 1000 grains (significance >0.05).

Table 2. Correlation of local rice agronomic characters and grain weight/clumps

Character Agronomy	Filled grain weight/clumps (g)	Productive tiller/ clumps (tiller)	Flag leaf area (cm2)	Panicle length (cm)	Filled grain number/ panicles (grain)	Empty grain number/ panicles (grain)	1000 grain weight(g)
Filled grain weight/clumps (g)	**1,000**	-0.568	0.906	0.797	0.980	0.029	0.534
Productive tiller/ clumps (tiller)	-0.568	**1,000**	-0.808	-0.525	-0.663	0.294	-0.474
Flag leaf area (cm2)	0.906	-0.808	**1,000**	0.806	0.957	0.007	0.396
Panicle length (cm)	0.797	-0.525	0.806	**1,000**	0.799	-0.314	0.296
Filled grain number/ panicles (grain)	0.980	-0.663	0.957	0.799	**1,000**	0.069	0.433
Empty grain number/ panicles (grain)	0.029	0.294	0.007	-0.314	0.069	**1,000**	-0.498
1000 grain weight(g)	0.534	-0.474	0.396	0.296	0.433	-0.498	**1,000**

The flag leaf area characteristics filled grain number/panicle, and panicle length have positive regression with the filled grain weight/clump (Figure 1). The regression equation for each of these local rice characters with the grain weight/clump is y = 2,199x + 2,895, y = 0.448x + 10,3722, and y = 12,300x – 192,752, respectively. Further analysis showed that flag leaf area and panicle length have highly significant regression with seed weight/clump. In addition, the positive linear regression between the filled grain number/panicle and the filled grain weight/panicle indicated that this character directly contributed to the yield. A similar report was reported in a previous study [15, 19]. The results of previous studies showed that the crucial role of flag leaf area on rice grain yield [13, 20,21]. Reduction of flag leaf area through cutting can reduce rice yield by about 15.69% to 29.43% [22], While the character that had no significant regression with filled grain weight/clump is the productive tiller, empty grain number/panicle, and 1,000 grain weight.

Table 3. Regression of local rice agronomic characters and grain weight/clumps

No.	Regression	Regression equation	Significance
1.	Productive tiller and filled grain weight/clumps	y = -10,105x + 360,887	0.183897tn
2.	Empty grain number/panicles and filled grain weight/clumps	y = 10,980x + 143,451	0.95011tn
3.	1,000 grain weight and filled grain weight/clumps	y = 16,027x – 205,347	0.217113 tn

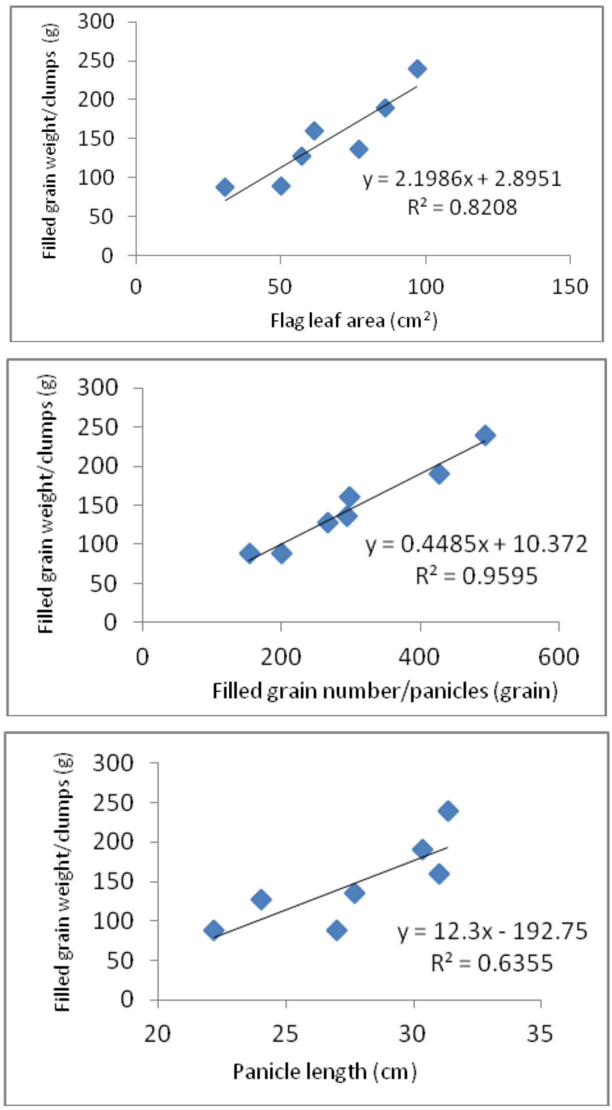

Fig. 1. Filled grain weight and flag leaf area, filled grain number and panicles length regression

The positive regression was highly significant, between the area of the flag leaf and the number of filled grain/panicle with the weight of the filled grain/panicle. A similar report was reported in a previous study [23, 24]. It is indicating that these two characters were the determinants of the weight of the grain/clump. The correlation between flag leaf area and the number of filled grains/panicles was very close and very significant, with values of r = 0.906 and r = 0.980 (Table 2), respectively. Based on Table 1 and Figure 1, Siem rice, Bolouh rice, and Gel rice have the potential to be used as parents (donor genes) in the creation of specific new high yielding varieties (broad flag leaves) and weight of grain content/high clump (high yield).

4 Conclusions

The agronomic characteristics of three local varieties of rice that determine the yield in the dryland of MURA and North MURA Regencies, South Sumatra, are the flag leaf area and the number of filled grain/panicles. Breeders can explore and utilize this information to create new high-yielding rice varieties in lowland dryland. The superior local varieties in these agronomic characters are Siem rice, Bolouh rice, and Gel rice. These varieties can potentially be used as parents (donor genes) in creating new high-yielding varieties. The acquisition of new high-yielding varieties specific to dryland through a breeding program will increase the choice of varieties for farmers/stakeholders and support increased rice production in dryland.

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