AGRONOMIC TRAITS OF LOCAL WETLAND RICE VARIETIES IN JAMBI PROVINCE

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ABSTRACT

Indonesia's swamplands are among areas earmarked for future agricultural development. As a type of wetlands, swamplands are inundated and have soil properties that are uniquely different from other agroecosystems. In Indonesia, some of these areas are currently used for rice cultivation of the country's very diverse genetic resources of local rice varieties. Most of the farmers continue to plant and cultivate the local rice swampland varieties because of the abilities to adapt to extreme environments. This study on the agronomic traits of the local swampland rice varieties was carried out to evaluate their agronomic characters and identify varieties having superior quality traits. The research was carried out from April to October 2016 using a single plot method at the Rantau Kapas Mudo Village, Batanghari Regency, Jambi Province. Eleven (11) rice varieties were planted in 10 x 5 m single plots, with a spacing of 25 x 25 cm and 1 m distance between plots. These 11 genetic resources of the local swampland rice varieties, include the Serendah Halus, Rimbun Daun, Karya, Serendah Bawang, Sereh Aek, Botol, Pontianak, Semut, Dawi, Ketan Itam and DI. The observed characters consisted of the plant height at harvest, number of productive tillers, age of harvest, number of grains per panicle, number of filled grains per panicle, number of empty grains per panicle, weight of 1,000 grains, seed shape and the production volume. There were differences among the local swampland rice varieties with the highest production volume of 3.32 tonnes/ha obtained from the Rimbun Daun variety, followed by 2.86 tonnes/ha from the Dawi variety. These two varieties had shown potential to become the leading regional swampland rice varieties.

Keywords: agronomic traits, local rice, swampland

INTRODUCTION

Swampland is a very unique agro-ecosystem with characteristically inundated soils. In Indonesia, it is one of those areas designated for future agricultural development (Noor & Fadjry 2008). Swampland is also distinguished by the presence or absence of the influence of a surrounding river. Those inundated by the surrounding river is called the river swamp, while the free or unaffected swampy area is called a caged or half-caged swamp (Kosman & Jumberi 1996).

Increasing rice production in swampland had increased farmers' income, and had supported food self-sufficiency (Djafar 1992). However, the main obstacle in swamp rice cultivation is the uncontrolled water flow that during the rainy season the entire area is inundated quite deep for quite a long time. This makes it difficult for farmers to estimate the rice planting period. Puddles that are too high during the vegetative phase due to flooding and heavy rains, occur after the seedlings are moved into the field. These are growth constraints that result in low production of even the low-yield rice variety. Almost synchronously, the risk of crop failure due to drought can also occur if there is no rain when the rice plants bloom (Swamp Research Center 2008). Hence, farmers generally plant rice varieties that are genetically adapted to the local growing environment in swamplands.

Germplasm is the fourth natural resource in addition to water, land and air resources which need to be conserved. Hence, preservation of

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germplasm as a genetic source will affect the success of agricultural development programs. The desired food sufficiency will depend on the regions' own germplasm diversity, because in reality superior varieties, which have been, are being, or will be produced are a collection of specific genetic diversity that is expressed in the desired superior qualities. The regional genetic resource is the starting point in the formation of plant varieties that produce high yield, are pests and diseases resistant, and are tolerant to environmental stress (Situmeang 2015).

Agricultural genetic resources (agro-biodiversity) are one of the most important germplasm to be protected from extinction and potential genetic erosion (Diwyanto & Setiadi 2008). In reality, these resources have been and will continue to be utilized for the survival and welfare of the community, at the local, regional, national, and global levels. As a mega-biodiverse country, Indonesia is currently thought to be rich in germplasm collection. However, Indonesia actually has inadequate collection of germplasm for producing superior varieties.

Genetic diversity is an economic, tourism, health and cultural resource. However, it is not evenly distributed in each region as it depends on the regional ecosystem (Wardana 2002). Natural resources utilization, accompanied by preservation of region-owned diversity and uniqueness, can be directed toward human welfare and carried out continuously from one generation to the next. The archipelagic nature of Indonesia with its various tribes and cultures, is closely related to genetic resource utilization which may vary between regions and agro-ecology. Cultural diversity together with agricultural genetic resources diversity will produce diversified community knowledge on resource utilization for food, shelter, clothing, medicines and industrial raw materials (Diwyanto & Setiadi 2008).

Among the various wetland agroecosystems (irrigation, rainfed and swamp) in Jambi Province, the swampland agroecosystems are the widest, comprising some 137,132 ha with the swampland area occupying 25,157 ha currently planted with local rice varieties (CPM 2016). These varieties are potential alternative food resources that need to be inventoried and conserved for the production of local superior varieties. Local rice varieties are those varieties that have long been adapted in certain areas and are generally consumed as food in its original form (Hajoeningtijas & Purnawanto 2013).

These local varieties need to be preserved as regional genetic resources and as a source of breeding material for future varieties improvement programs (ARDA 2013; Rais 2004). The characteristics of these local rice varieties are largely not well identified, so knowledge on their potential and development opportunities as superior local rice varieties is still lacking. In the field, their local population still looks diverse, particularly the plant height, ripening or harvest age, shape, and grain color.

The local varieties have adapted to certain environmental conditions and were characterized based on their low production rate, high and strong trunk, chronic unresponsiveness to input or fertilization, diverse physical characteristics, delicious taste, popularity among many consumers, and high market price.

This will affect farmers' production of rice. Seeds of local rice varieties used by farmers are also of low quality because they are continuously obtained from farmers' rice crops and inherited from generation to generation (Bobihoe 2014).

The purpose of this study is, therefore, to determine the characteristics of local rice in swampland and to discover the varieties that have superior qualities based on their agronomic characteristics. These results are expected to help expand opportunities to produce novel rice varieties with better qualities thereby improving rice productivity in the swamplands.

MATERIALS AND METHODS

The research activities were carried out from April to October 2016 at Rantau Kapas Mudo Village, Batanghari Regency, Jambi Province. Eleven (11) local varieties of swampland rice were studied, namely Serendah Halus, Rimbun Daun, Karya, Serendah Bawang, Sereh Aek, Botol, Pontianak, Semut, Dawi, Ketan Itam, and DI. Using the single plot method, each variety was planted in a 10 x 5 m single plots with 25 x 25 cm spacing and 1 m distance between plots.

The study location was classified as low-lying, lower topography with a pool of water between

50 and 100 cm deep during a period between three and six months. The swampyland is generally muddy and has a medium to high soil fertility (Waluyo & Suparwoto 2016).

The observed parameters included those at the vegetative and reproductive phases. The vegetative characters consisted of the plant height at harvest (measured from the base of the stem to the highest tip of panicle), the number of productive tillers (calculated at the time of harvest). The generative characters were measured after harvest time and consisted of the harvest age (calculated from the number of days after planting), number of grains (counted number of grains) per panicle, number of filled grain (calculated number of filled grains) per panicle, number of empty grains (calculated number of empty grains) per panicle, weight of 1,000 grains (weight of 1,000 grains of grain content), and yield (tonnes/ha). Plant data were observed agronomically and tabulated for 10 clumps of rice plants.

RESULTS AND DISCUSSION

Eleven (11) local swamp rice varieties characterized in terms of agronomical traits, consisted of Serendah Halus, Leaf Rimbun, Karya, Serendah Bawang, SerehAek, Bottle, Pontianak, Semut, Dawi, KetanItam, and DI (Table 1). These were chosen from the farmers' fields located at Rantau Kapas Mudo Village, Muaro Tembesi District, Jambi Province, Indonesia.

Vegetative Characteristics of the Rice Plants

Plant Height

The height of the tested local rice varieties ranged between 86.2 and 147.6 cm with Serendah Bawang being the tallest at 147.6 cm, and Botol the shortest at 86.2 cm (Table 1). The crops were classified into three categories based on their height, i.e., short (<110 cm), medium (110 to 130 cm), and tall (>130). The local rice varieties were generally tall (>130 cm) (scale 5) except Botol, Dawi, and DI (<110 cm) (scale 1).

The plant heights were measured at the start of the harvest. Medium-height plants (110 - 130 cm) more likely developed more productive tillers than taller crops, as tall crops use up photosynthates for vegetative growth, making photosynthesis less efficient.

The results showed that the rice cultivation system in the swampland produced taller plants than that in the upland cultivation system. Rice plant heights can be used as a parameter of rice growth, but taller plants do not guarantee greater yields (Kristia & Iskandar 2018). Plant height is one component that influences a plant's weight. The desired characteristics in the development of superior rice varieties are stems that are short and stiff, considering that plants with this characteristic will be resistant to fall, be responsive to fertilization, and have a more balanced proportion between grain and straw. Another characteristic is the plants' absorption of N; the higher the performance of a plant, the higher the likelihood of its vulnerability (Kristia & Iskandar 2018).

Table 1 Vegetative characteristics of the local swampland rice varieties

No.	Variety name	Plant height* (cm)	Number of productive tillers** (tiller)
1.	Botol	86.2	10
2.	Pontianak	139	10
3.	Semut	120.8	10
4.	Dawi	91.3	13
5.	Ketan Hitam	111.4	9
6.	DI	104.7	10
7.	Serendah Halus	141.4	7
8.	Rimbun Daun	132.9	10
9.	Karya	140.6	9
10.	Serendah Bawang	147.6	6
11.	Sereh Aek	143.6	9

Notes: * = Average plant height at harvest (cm); ** = Number of productive tillers at harvest (tillers).

Among the selection criteria for rice plants, height is related to the length and shortness of the panicles and to the shedding resistance of plant stems. Plants tend to be shorter at locations higher than sea level (Simanulang 2001). Although plant height is one selection criteria for rice plants, nevertheless, taller stems do not influence the level of production (Suprapto & Dradjat 2005).

High plant growth does not guarantee high plant productivity. Optimal plant growth has a large influence on the relationship between panicle length and yield. Plants that grow well absorbs large quantities of nutrients. The availability of these nutrients in the soil influences photosynthetic activity in a way that plants can increase crop growth and yield (Aribawa 2012).

Number of productive tillers

The number of productive tillers varied from 6 to 13 with the highest number produced in the Karya variety (13 tillers) and the lowest number in Serendah Bawang (6 tillers). This low number of tillers is probably due to the submersion of the initial seedling for about a week, thus inhibiting the formation of saplings (ICR 2016).

High and low plant growth and yield are also influenced by internal factors which include genetic traits and plant derivatives, and the external or environmental factors, such as soil regime and biotic factors (Cepy & Wayan 2011). The different number of tillers produced by each variety is thought to be due to the influence of these factors. The number of tillers and plant height differs because the genetic properties of each variety also differ (Manurung & Ismunadji 1988).

Productive tillers directly affect the high and low yields of grain as it greatly determines the number of panicles (Simanulang 2001). More productive tiller means more number of panicles. In this study, a correlation exists between the number of panicles and yield; the higher number of panicles resulted in higher yield of the plants.

Generative characteristics of the Rice Plants

In the generative growth phase, the characteristics observed included the harvest age, number of grains, number of filled grains, empty grains, weight of 1,000 grains, age of harvest and yield (Table 2).

Harvest period (number of days after seedling)

Generally, the cultivation ages for rice crop are categorized into early age (about 110 days) and old age (more than 120 days). The local rice varieties are generally old at >151 days after seedling stage, while high yielding varieties mature at 105 - 124 days after seedling stage (ICRR 2016). The local swamp rice cultivars are generally cultivated within 150 days, while the local variety is cultivated at an early age (120 days for Karya). Obviously, shorter harvest age is preferred by farmers because it means shorter harvest time gaps and more frequent harvest periods.

Table 2 Yield components of the local landraces of swampland

No.	Variety name	Harvest age[1] (DAP)	Number of grain per panicle[2] (grain)	Number of filled grains per panicle[3] (grain)	Number of empty grain per panicle[4] (grain)	Weight of 1,000 grains[5] (g)	Volume production[6] (tonnes/ha)
1.	Botol	150	132	74	58	22	2.32
2.	Pontianak	150	122	88	34	23	2.24
3.	Semut	150	113	49	64	14	1.26
4.	Dawi	150	172	80	92	16	2.86
5.	Ketan Hitam	150	136	82	54	21	2.05
6.	DI	150	132	78	54	23	2.42
7.	Serendah Halus	150	151	61	90	21	1.77
8.	Rimbun Daun	150	173	86	87	24	3.32
9.	Karya	120	137	47	90	19	1.97
10.	Serendah Bawang	150	170	103	67	25	2.04
11.	Sereh Aek	150	165	73	83	20	2.37

Notes: 1 = Average age of harvest (day after planting); 2 = number of grain per panicle (grain); 3 = number of filled grains per panicle (grain); 4 = number of empty grain per panicle (grain) (Empty grains were generally found at the base of panicles); 5 = weight of 1,000 grains (g); and 6 = volume production (ton/ha) of local rice swamp varieties.

Number of grains per panicle (grains), number of filled grains per panicle (grains), number of empty grains per panicle (grains).

The Dawi and Rimbun Daun varieties produced the highest number of grains per panicle, 172 and 173 grains per panicle, respectively, while the Semut variety produced the least numbers of grains per panicle at 113 grains/panicle.

Moreover, Serendah Bawang variety had the highest grain content at 103 filled grains, while Semut variety had the least grain content at 42 filled grains. The lowest number of empty or unhulled grains was produced in the Pontianak variety at 34 grains while the highest number was found in Dawi variety at 92 grains.

This high number of empty grains showed the inability of those plants to fill their own grains. Such a low yield can be due to genetic or environmental factors. Empty grains affect the rice yield; the higher the percentage of empty grains, the lower the rice yield would be. Consequently, higher proportion of empty seeds would result in lower rice production. The number of filled grains per panicle correlates with rice yield, hence, it is one of the criteria for a high yielding rice variety. Although the number of filled grains is markedly correlated with rice crop yield, the latter variable is still strongly influenced by the number of empty grains. Likewise, the weight of grain contents also determines the weight of the yield. Empty seeds also affect the rice yield; the higher the percentage of empty grains, the greater the effect on rice yields. New types of rice varieties with high yield potential, generally possess the following characteristics, namely (1) the number of grains per panicle is between 150 and 250 grains; (2) the percentage of filled grains is between 85% and 95%; and (3) the percentage of empty grains is between 5 and 15% (Abdullah 2008).

Generally, the number of grains per panicle is positively correlated with panicle length. The longer the panicle is formed, the more amount of grain is accommodated by the concerned panicle. Meanwhile, the number of filled grains and the weight of 1,000 grains formed in one panicle is highly dependent on the photosynthesis (seed filling) of the plants during their growth and on the genetic properties of the cultivated rice plants (Ariwibawa 2012).

Weight per 1,000 grains (g) and weight of yield (tonnes/ha)

The weight per 1,000 grains of each variety varied between 14 g and 25 g. The highest weight per 1,000 grains was produced in the Serendah Bawang variety at 25 g, while the lowest was found in the Semut variety at 14 g. Weight per 1,000 grains indirectly describes the size or enormity of a rice grain. The higher the weight per 1,000 grains of a rice variety, the larger is its grain size, and vice versa. The grain size is affected by its genetic properties and adaptability to its growing environment. During the dry season, the highlands with their low temperatures, affect the weight of the 1,000 grains.

The difference in weight per 1,000 grains of plants determines the ability of a variety to produce a lot of grains which is often inversely proportional to its ability to produce large and heavy grains, nevertheless, a high production rate can still be achieved with a large number of grains, even though the grain size is smaller (Simanulang 2001). Weight of the 1,000 grains indirectly illustrates the grain size of a rice variety. Strains/varieties with large grains produce higher weights of the 1,000 grains and vice versa. Grain size is influenced by genetic traits and adaptability to the growing environment. Hence, rice yield is also affected by the the weight of the 1,000 grains.

Finally, of all the varieties tested, Rimbun Daun produced the highest yield at 3.32 tonnes/ha. This result coincides with that of the number of grains per panicle where the Rimbun Daun variety produced the highest yield of 173 grains, while the lowest yield was at 1.26 tonnes/ha in the Semut variety. This result also confirmed the effects of both the lowest number of filled grains per panicle and the lowest weight per 1,000 grains on the production volume of the Semut variety. Plant yield is determined by its components' yield. Hence, an imbalance in the components will greatly influence the expected potential result. Similarly, rice yield is determined by its yield components, such as the number of filled grains per panicle and the weight per 1,000 grains. Correlation of the plant's tangible yield with its weight per 1,000 grains and its number of filled grains per panicle is one of the criteria for selecting the rice variety which can produce a high yield (Manurung & Ismunadji 1988).

The yield per hectare of the eleven tested local swamp rice varieties planted on *lebak* swamp showed that two local varieties produced the two highest yields of more than 2.5 tonnes per ha, namely; Rimbun Daun at 3.32 tonnes/ha and Dawi at 2.86 tonnes/ha. These two varieties have shown some potential for becoming the superior local rice varieties.

Finally, with the use of appropriate cultivation technology, these two local rice swamp varieties will produce their expected potential yield.

CONCLUSION

In summary, two local rice varieties have exhibited high yield potential of above 2.5 tonnes per hectare, namely; Rimbun Daun at 3.32 tonnes/ha, and Dawi at 2.86 tonnes/ha. These two varieties have shown some potential for large scale production and prospects of becoming the leading rice varieties in the swampy areas.

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