BIODIVERSITAS
Volume 23, Number 2, February 2022
Pages: 1058-1064

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d230249

Variability, heritability, and performance of 28 West Sumatran upland rice cultivars, Indonesia

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Manuscript received: 28 December 2021. Revision accepted: 27 January 2022

Abstract. *Marwan AP, Munandar A, Anwar A, Syarif A, Hayati PKD. 2022. Variability, heritability, and performance of 28 West Sumatran upland rice cultivars, Indonesia. Biodiversitas 23: 1058-1064.* The abundance of genetic diversity, especially local upland rice cultivars, makes an excellent opportunity to obtain local cultivars with the desirable character. The study aimed to assess the genetic variability and heritability of agronomic traits among local upland rice cultivars from West Sumatra. In this study, 28 local upland cultivars from West Sumatra were subjected to the analysis of variance. The research was conducted from November 2020 to April 2021 at the Research Station of the Faculty of Agriculture, Andalas University, Padang. The evaluation was conducted using a Randomized Complete Block Design with three replicates. Results showed variation in each agronomic trait, ranging from intermediate to tall in plant height, short to moderate in panicle length, low to moderate in the number of tillers, days to flowering and days to maturity, and light to moderate in grain yield. Plant height, number of tillers, days to flowering, and days to maturity were traits with high to moderately high GCV values and high heritability values. The number of tillers and days to maturity could be chosen as selection criteria for assembling superior varieties. Both traits performed high heritability estimates and significant genotypic correlation with grain yield.

Keywords: Characterization, genetic diversity, local cultivars, rice

Abbreviations: GCV: Genotypic Coefficient of Variation; PCV: Phenotypic Coefficient of Variation; DAP: days after planting

INTRODUCTION

Rice is the staple food in Indonesia. Based on the Food Security Agency Ministry of Agriculture (2019), rice consumption in Indonesia in 2018 was recorded at 97.1 kg cap^{-1} year^{-1}. West Sumatra is one of the provinces in Indonesia where the majority of the people consume rice as a primary source of carbohydrates. The reduction of rice field areas in West Sumatra challenges sustaining food security and self-sufficiency in the future. According to Agricultural Data Center and Information System (2020), rice fields in West Sumatra have decreased by 12.67% from 2015 to 2019. Upland rice is one solution that can answer these challenges due to the availability of dryland in West Sumatra that attains an area of 323,908 ha (Agricultural Data Center and Information System 2020).

Upland rice cultivation has many advantages; it does not require intensive cultivation and irrigation, planting as an intercrop, is adaptive to drought, and have specific traits such as a fragrant aroma (Arsa et al. 2017; Malik 2017; Marpaung and Ratmini 2018). However, long periods to harvest, tall plant height, relatively few tillers, and low yield become problems for the local upland cultivars. Therefore, it is necessary to develop local upland rice cultivars of West Sumatra that are adaptive to environmental conditions and have specific qualities that meet the preference of consumers of West Sumatra.

The diversity of upland rice germplasm in West Sumatra allows breeders to generate new superior varieties through selection. Selection is a crucial stage in plant breeding (Kristamtini et al. 2020). Selection progress depends on the magnitude of genetic diversity. Comprehensive knowledge of genetic availability and diversity is needed for crop improvement and the future development of new high-yielding varieties (Malek et al. 2014; Adie and Krisnawati 2017; Weerakoon and Somarate 2021). The study of genetic diversity in local upland rice cultivars based on agro-morphological traits can provide reliable information for selection and further work on producing new superior varieties (Mau et al. 2017). The higher variability of, the traits the immense opportunity to obtain the desirable traits and candidate as a new potential cultivar.

Estimates of heritability play an essential role in plant improvement based on plant selection because it implies the extent to which traits are passed on to offspring (Mazid et al. 2013). Heritability estimate is a genetic parameter that shows the portion of genetic variance to the phenotypic and examines the ability of parents to pass the traits to their offspring (Falconer and Mackay 1996). The effectiveness of selection depends on the extent of variability and heritability estimates (Poehlman 1995). The selection of a character will be more effective when its diversity and heritability value are high (Ismail et al. 2015; Hastuti et al.

2016). This study aimed to assess the genetic variability and heritability of agronomic traits of local upland rice cultivars from West Sumatra.

MATERIALS AND METHODS

Study area

The research was conducted from November 2020 to April 2021 at the Research Station of the Faculty of Agriculture (0º55'23.3"S 100º27'16.8"E), Andalas University, Padang, Indonesia. The average daily temperature from November 2020 to April 2021 ranged from 28.08ºC to 26.96ºC. The materials used were 28 local upland rice cultivars from exploration previously conducted in three regencies in West Sumatra (Table 1) and Jatiluhur as a check variety. The study used a Randomized Complete Block design with three replicates. Each experimental unit consisted of 16 plants with four plants as samples.

Procedures

Preparation of soil consisted of soil plowed and 1 t ha^{-1} dolomite application to attain the soil pH 5.0 before planting. Each cultivar was planted directly with three seeds per hole and then let only one seedling 14 days after planting (DAP). The spacing used was 25 cm x 25 cm. All agronomic practices followed standard recommendations to raise a healthy and good crop establishment. The traits observed in the study were plant height (cm), panicle length (cm), total tiller number (tillers per-plant), days to flowering 50% (DAP), days to maturity 90% (DAP), and grain yield per plant (g) (IRRI 2013).

Data analysis

Analysis of variance (ANOVA) was carried out on the observed agronomic data. If the F-count value on the ANOVA is significantly different, then the LSD (Least Significance Different) test was further carried out at the αlevel of 5%. In addition, genetic parameters such as the variance of genetic (σ^2g) and variance of phenotype (σ^2p), genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV), and broad-sense heritability (H) were calculated based on variance components of the ANOVA (Table 2).

The formula used to calculate genotypic and phenotypic variance and heritability estimates were:

Variance of genetic

$$\sigma^2 g = \frac{MSG - MSE}{r}$$

MSE : Mean Square of Error
MSG: Mean Square of Genotype
r : Replication

Variance of phenotype

$$\sigma^2 p = \sigma^2 g + \sigma^2 e$$

The coefficient of genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) was calculated based on the formulae of Singh and Chaudhary (1979).

$$GCV = \frac{\sqrt{\sigma^2 g}}{\bar{X}} \times 100\%$$

$$PCV = \frac{\sqrt{\sigma^2 p}}{\bar{X}} \times 100\%$$

σ^2g : Variance of Genotype
σ^2p : Variance of Phenotype
$\bar{X}$: mean of trait

While the estimated value of heritability (H) was calculated as:

$$H = \frac{\sigma^2 g}{\sigma^2 p}$$

Table 1. Origin (district) and name of a local upland cultivar

Origin (district)	Cultivar
Pasaman	Anam Ampek, Pahlawan, Sibagindit, Sigendut Putiah, Sikuriak, Sikuriak Basunguik, Silampung 2, Simaritik, Sipahlawan, Sipuluik (Ketan), Sirumpun, Sirah Gadang, and Sirah Kualo
West Pasaman	Buyar, Seribu Goyang, Silampung, Siburnut, Sigadih Burai, Sikerang, Siputih, Sigudang, and Telur Iken
South Solok	Cupak, Peconina Kuning, Peconina Merah, Siguling Tandai, Simerah Tandai, and Sipulutan

Table 2. Component of the ANOVA of randomized complete block experimental design

Source of variation	d.f.	Mean squares	Expected mean squares
Block	r-1	MSB	$\sigma^2_e + g\sigma^2_B$
Genotypes	g-1	MSG	$\sigma^2_e + r\sigma^2_G$
Error	(g-1) (r-1)	MSE	σ^2_e

Note: σ^2_B: Variance of blocks; σ^2_G: Variance of genotypes; σ^2_e: Variance of environments; r: number of replications; g: number of genotypes; MSB: Mean Square of Block; MSG: Mean Square of Genotype; and MSE: Mean Square of Error

RESULTS AND DISCUSSION

Genetic variability and heritability of agronomic traits

The value of variability and the estimated heritability are essential components that must be measured before determining the method and time for selection (Mustikarini et al. 2019). The coefficient of genotypic variation (GCV) and the coefficient of phenotypic variation (PCV) are very useful in determining the amount of diversity that exists in the population and are the basis for variability criteria (Mustikarini et al. 2019; Saidon et al. 2020). All traits showed high PCV than GCV, similar to the results reported by Srivastava et al. (2017); Tiruneh et al. (2021), indicating that the variance observed for the traits was more influenced by the genetic factors and suitable environment support the expression of genetic (Kartahadimaja et al. 2021). A notable difference in PCV and GCV values indicates a significant environmental influence positively on the traits. In contrast, a higher value of GCV than PCV indicates that the genetic role is more significant than the environmental effect (Seyoum et al. 2012). A variation on PCV and GCV values on upland rice cultivars was also reported by Tuhina-Khatun et al. (2015) (Table 3).

There are four criteria for GCV and PCV values, i.e., 0-25%: low, 26-50%: moderately low, 51-75%: moderately high, and 76-100%: high (Hayati 2018). In this study, GCV had high criteria for the character of plant height, the number of tillers, days to flowering, and grain yield. Moderate and low criteria were found on days to maturity and panicle length, respectively. In PCV, only grain yield traits have high criteria. The traits of plant height and the number of tillers have PVC with moderate criteria; meanwhile, the panicle length, days to flowering, and days to maturity traits performed PCV with low criteria. A high GCV value is important in the selection of the trait.

An important function of the heritability estimate is the correspondence between the phenotypic and genotypic variance. According to Stansfield (1991), the heritability value is high if it is >0.5; heritability 0.2-0.5 is moderate, while heritability <0.2 is low. Heritability estimates are high for plant height, the number of tillers, days to flowering and days to maturity, moderate for grain yield, and low for panicle length (Table 3). High heritability estimates in plant height, the number of tillers, days to flowering, and days to maturity indicate that genetic factors play a critical role in the variance of the traits. The higher genetic factors control the trait, the greater possibility of passing the trait on to their offspring. The selection of the traits will be more effective (Roslim et al. 2015; Hayati 2018).

Moderate (grain yield per plant) and low (panicle length) heritability estimates have a slight chance of passing on the traits to their offspring. Moderate and low heritability values indicate that the appearance of plant phenotypes is more influenced by environmental factors than genetic factors (Mustakim et al. 2019). Traits with low or moderate heritability have a low chance of being passed on to their offspring; therefore, selecting these traits tends to be ineffective, and the assembly of superior traits will be difficult to achieve. The selection of traits that have high heritability and high-positive correlation with the important traits is critical in a plant breeding program because the characters will have a high opportunity to be passed on to their offspring and facilitate the selection of the desired traits.

Genotypic and phenotypic correlation among quantitative traits

Genetic correlation analysis includes two main components, i.e. phenotypic correlation and genotypic correlation. Phenotypic correlation is the relationship between two different traits that can be observed directly. Phenotypic correlation is influenced by genetic variation and environmental variation. In contrast, genotypic correlation is only influenced by the gene's action to control the traits. Genetic correlation analysis has an essential role in plant breeding, especially selection. Selection is carried out on economic value traits, but a selected trait tends to cause changes in other traits. A particular trait becomes important when they are correlated with essential traits. The economic value of the upland rice trait is grain yield.

Table 3. Genetic variability and heritability of agronomic traits evaluated from 28 local upland rice cultivars

Traits	Mean of square	VG	VP	GCV (%)	Criteria	PCV (%)	Criteria	H	Criteria
Plant height	1970.47	608.98	752.51	16.50	Hi	18.34	MH	0.81	Hi
Panicle length	15.10	1.58	11.94	4.74	L	13.03	ML	0.13	L
The number of tillers	17.00	4.78	7.45	16.49	Hi	20.60	MH	0.64	Hi
Days to flowering	776.26	258.56	259.14	16.55	Hi	16.57	ML	0.99	Hi
Days to maturity	639.27	212.93	213.40	11.07	MH	11.08	ML	0.99	Hi
Grain yield	53.61	12.00	29.61	21.72	Hi	34.12	Hi	0.41	M

Note: VG: Variance of Genotype; VP: Variance of Phenotype; GCV: Genotypic Coefficient of Variation; PCV: Phenotypic Coefficient of Variation; H: Heritability, Hi: High; MH: Moderately High; ML: Moderately Low; L: Low; M: Moderate

There was a positively significant genotypic correlation between grain yield and the number of tillers (r=0.32*), while negatively correlated with days to maturity (r=-0.30*) (Table 4). This result indicates a consistent relationship between grain yield and the addition of tillers. Meanwhile, the relationship between grain yield and days to maturity is inversely proportional, where days to maturity occur earlier and grain yield increases. The relationship between grain yield and the number of tillers is very beneficial for plant breeders because they can predict high grain yields earlier; therefore, time and energy are more profitable. A positive genotypic coefficient correlation indicates a possible linkage between the genes of the two traits (i.e. cis or coupling), while a negative correlation indicates a possible trans or repulsion (Timisela et al. 2020). In contrast, there is no phenotypic correlation between grain yield and other traits, indicating that the relationship between grain yield and other traits is influenced mainly by genetic factors.

The number of tillers had significant negative genotypic correlations with days to flowering, while no phenotypic correlation between the traits. The number of tillers had a significant negative correlation with days to maturity, both genetically and phenotypically. This association indicates that more tillers will be obtained with the earlier maturity of cultivars. High and significant coefficient correlations were found between days to flowering and days to maturity. Positive correlations of flowering date with maturity date showed a corresponding increase in these traits or vice versa.

Plant breeders usually prefer a shorter plant height. There were significant genotypic and phenotypic correlations between plant height and other traits. Plant height positively correlated with panicle length, days to flowering, and days to maturity, and negatively correlated with the number of tillers. Likewise were found in the phenotypic correlation. Consistently higher genotypic coefficient correlations for the traits than phenotypic coefficient correlations indicate that the genetic factors of the cultivars evaluated dominated the association among traits.

Panicle length was positively correlated with days to flowering and maturity and negatively correlated with the number of tillers. On the other hand, there were no phenotypic correlations between panicle length and the number of tillers, days to flowering, and days to maturity. Changes in panicle length, the number of tillers, and days to flowering and maturity genotypic coefficient correlation to a not-significant phenotypic correlation indicated that genetics played a greater role in the relationship between the traits.

Growth, flowering, and yield performance

Based on the analysis of variance (ANOVA), there were significant differences in plant height, the number of tillers, days to flowering, days to maturity, and grain yield per-plant among 28 cultivars and check variety evaluated. Observation of plant height on 28 local upland rice cultivars of West Sumatra showed varying results with plant height ranging from 99.33-197.33 cm. Based on Standard Evaluation System for Rice, the plant height can be classified as semi-dwarf (<90 cm), intermediate (90-125 cm), and tall (>125 cm) (IRRI 2013). Table 5 showed that the tall plant category dominated the plant height covering 78.57% of the 28 existing cultivars. Tall criteria were reported by Zen and Syarif (2013) for 5 Pasaman upland rice, 12 North Sumatra upland rice by Chaniago (2017), 7 East Aceh upland rice (Syahril 2017), and 30 Kalimantan upland rice (Suyadi et al. 2019).

Upland rice with tall criteria is prone to lodging. Upland rice with a tall plant height performance could easily fall to rain and strong winds, especially during flowering and grain filling (Zhu et al. 2016; Suyadi et al. 2019). Phapumma et al. (2020) reported that plants with a tall appearance are not favorable traits for grain yield. Plants with a semi-dwarf performance are more desirable than tall ones because semi-dwarf plants are stronger in facing environmental factors such as wind and rain (Mau et al. 2017; Hermanasari et al. 2021). Hence semi-dwarf plant height becomes an essential trait for the breeder in the rice improvement program. Although the appearance of the dominant plant height is high, there are cultivars with intermediate criteria so that they have the opportunity to be developed or to become selection material in the assembly of superior varieties. Cultivars with intermediate criteria were Anam Ampek, Sibagindit, Sikerang, Sikuriak, Sikuriak Basunguik, and Silampung 2.

Each cultivar had different panicle length traits. Panicle length can be classified into four criteria; Very short (<11-15 cm), Short (15-25 cm), Moderate (25-35 cm), Long (35-40 cm), and Very long (>40 cm) (Bioversity International and WARDA 2007). The panicle length of the 28 local cultivars evaluated cultivars ranged from 22.33 cm to 33 cm and was grouped into two criteria, i.e. short and moderate panicle length. Cupak has the longest panicle (33 cm) among the 28 existing West Sumatran local cultivars. Variation in panicle length with moderate to long criteria was also reported by Fatonah et al. (2019); Zulputra (2019); and Kikuta et al. (2020). Panicle length is one of the parameters determining rice plants' high or low production. The length of the panicle affects grain yield because the longer the panicle, the more grains gained (Mahmud and Purnomo 2014). The grain yield per plant will increase in line with the length of the panicle size (Hermanasari et al. 2021).

The criteria for the number of tillers is divided into five, i.e. very high (>25), high (20-25), moderate (10-19), low (5-9), and very low (<5) (IRRI 2013). The number of tillers of the 28 cultivars ranged between 7.33-15.67 tillers. All cultivars had moderate tiller numbers, except for Cupak and Sigadih Burai with low numbers of the tiller. On average, no local cultivar produced more tiller numbers than the check variety. The low and moderate tiller numbers of local upland rice cultivars were reported by Darmawan et al. (2019) in Gorontalo local rice, while moderate criteria were reported by Chaniago (2017) on North Sumatra upland rice. Kadidaa et al. (2017) reported low criteria tiller number in North Buton upland rice and Supriadin et al. (2013) in Banggai upland rice, with an average tiller number of 3.06.

Table 4. Genotypic and phenotypic coefficients correlation among various traits in upland rice local of West Sumatra, Indonesia

Traits	Grain yield	Plant height	Panicle length	Number of tillers	Days to flowering	Days to maturity
Grain Yield		-0.26 ns	-0.12 ns	0.32*	-0.20 ns	-0.30*
Plant Height	-0.04 ns		0.92**	-0.61*	0.76**	0.81**
Panicle Length	0.24 ns	0.49**		-0.72*	0.33*	0.45**
Number of Tillers	0.19 ns	-0.44*	-0.23 ns		-0.27 *	-0.38 *
Days to Flowering	-0.12 ns	0.67**	0.12 ns	-0.22 ns		0.97**
Days to Maturity	-0.20 ns	0.72**	0.16 ns	-0.31*	0.97**	

Note: Numbers in bold are phenotypic coefficient correlations; while numbers in italic are genotypic coefficient correlations; *and** significantly at 5 and 1%, respectively. ns: not significantly

Table 5. Plant height, panicle length, the number of tillers, days to flowering, days to maturity, and grain yield per plant of 28 local upland rice and Jatiluhur cultivars

Cultivar	Plant height (cm)	Panicle length (cm)	Number of tillers (tillers per-plant)	Days to flowering (dap)	Days to maturity (dap)	Grain yield (g)
Anam Ampek	111.00±6.24 *	23.50±3.12	16.00±1.00 ns	82.67±0.58 *	116.67±0.58 *	16.92±2.99 ns
Buyar	136.77±10.01 ns	27.07±4.24	16.67±1.15 ns	82.00±1.00 *	113.00±1.00 ns	30.39±0.44 *
Cupak	197.33±4.04 *	33.00±5.20	7.67±0.58 *	85.00±1.00 ns	133.00±1.00 *	11.90±0.94 ns
Pahlawan	157.00±10.58 *	28.70±1.57	13.33±0.58 ns	96.67±0.58 *	131.33±0.58 *	18.30±2.66 ns
Peconina Kuning	144.40±11.11 ns	27.67±4.04	15.33±2.08 ns	88.33±0.58 *	120.33±0.58 *	19.63±5.57 ns
Peconina Merah	151.00±12.29 ns	26.00±4.36	14.00±1.00 ns	93.67±0.58 *	123.67±0.58 *	14.15±3.46 ns
Seribu Goyang	161.00±16.52 *	28.00±1.73	10.67±2.08 *	95.67±1.15 *	131.67±0.58 *	14.69±8.78 ns
Silampung	129.33±16.17 ns	24.17±0.76	12.00±1.00 *	77.00±1.73 *	111.67±0.58 *	14.31±0.89 ns
Sibagindit	99.33±7.64 *	26.33±2.89	15.33±1.15 ns	83.33±0.58 ns	121.67±0.58 *	19.28±5.41 ns
Siburnut	160.83±5.35 *	28.83±1.04	14.33±2.52 ns	116.67±0.58 *	148.00±1.00 *	10.51±1.30 ns
Sigadih Burai	159.33±10.26 *	26.33±1.53	8.67±0.58 *	96.33±0.58 *	134.67±0.58 *	12.68±4.91 ns
Sigendut Putiah	156.33±3.06 *	26.00±3.61	11.33±1.53 *	87.00±0.00 *	123.00±0.00 *	14.55±3.54 ns
Siguling Tandai	173.00±6.00 *	28.00±1.00	12.67±1.53 *	105.00±0.00 *	143.00±0.00 *	15.81±3.64 ns
Sikerang	119.00±18.00 *	22.33±2.08	15.00±1.73 ns	88.67±1.53 *	125.67±1.15 *	11.56±3.83 ns
Sikuriak	110.00±8.54 *	25.00±2.65	16.33±2.08 ns	73.67±1.53 *	112.33±1.15 *	11.74±1.57 ns
Sikuriak Basunguik	122.67±9.24 ns	25.00±1.73	16.67±0.58 ns	74.33±1.15 *	113.33±0.58 ns	22.86±3.43 ns
Silampung 2	116.17±4.91 *	25.00±3.00	15.67±0.58 ns	80.67±0.58 *	116.33±0.58 *	10.17±1.50 *
Simaritik	134.33±6.43 ns	23.33±4.62	13.67±3.21 ns	95.00±0.00 *	132.00±0.00 *	13.48±3.66 ns
Sipahlawan	132.00±15.72 ns	29.00±2.00	10.67±2.08 *	94.00±1.00 *	126.67±0.58 *	19.48±5.24 ns
Sipuluik (Ketan)	159.33±4.04 *	29.67±0.58	14.67±1.53 ns	90.00±0.00 *	122.00±0.00 *	16.05±3.15 ns
Siputih	179.67±21.59 *	27.17±5.06	11.33±2.08 *	123.00±1.00 *	156.00±1.00 *	14.84±3.86 ns
Sirumpun	183.67±12.10 *	26.83±2.75	13.33±1.53 ns	126.33±0.58 *	157.00±1.00 *	14.01±4.37 ns
Sigudang	141.67±7.77 ns	24.00±2.00	10.33±0.58 *	98.00±0.00 *	130.00±0.00 *	18.46±5.35 ns
Simerah Tandai	158.33±11.02 *	26.00±5.29	11.33±3.06 *	117.00±0.00 *	147.33±0.58 *	18.07±5.84 ns
Sipulutan	190.00±21.70 *	27.67±3.21	14.67±2.08 ns	126.67±0.58 *	157.00±1.00 *	19.22±2.00 ns
Sirah Gadang	165.33±3.51 *	26.50±2.60	13.33±1.53 ns	113.33±0.58 *	146.33±0.58 *	17.13±0.47 ns
Sirah Kualo	169.67±12.70 *	24.67±0.58	14.00±1.73 ns	117.00±0.00 *	150.00±0.00 *	6.58±0.49 *
Telur Iken	168.70±25.09 *	26.67±5.77	12.00±1.00 *	112.67±0.58 *	146.33±0.58 *	19.73±9.15 ns
Cultivars means	149.54±25.63	26.52±2.24	13.25±2.38	97.13±16.09	131.80±14.60	15.95±4.60
Jatiluhur	137.00±2.00	25.67±1.53	15.33±0.58	84.00±1.00	114.00±1.00	17.25±1.17

Note: Data in the same column, followed by a *, were significantly different based on the LSD test (0.05) against the check variety Jatiluhur, while the data in the same column followed by the ns sign, were not significantly different based on the LSD test (0.05) against the Jatiluhur check variety

The ability of a plant to produce tillers varied depending on the variety or cultivar used. The traits of the tiller numbers can be observed starting from the initial growth phase until the maximum tiller, which is reached in the grain filling phase (Afza et al. 2020). Based on the correlation analysis performed, the plant height was negatively correlated with the number of tillers, both in phenotypic and genotypic correlation. The number of tillers also has a positive genotypic correlation with grain yield, which indicates an increase in the number of tillers as grain yield increases, so this can be used as a trait for early selection or early stage to assess the yield ability of local cultivars. The number of tillers will affect the amount of grain produced because the more tillers, the more panicles there will be, and it will affect the production of the plants (Lubis 2020; Phapumma et al. 2020; Sution and Agus 2020). The Buyar cultivar had the most tillers, with an average tiller per plant of 16.67 tillers. It also produced the heaviest grain yield, with an average weight of 30.39 g. Cupak cultivar with the least number of tillers had the lowest grain yield per plant, weighing at 11.90 g. Two cultivars with low criteria in the number of tillers, i.e. Cupak and Sigadih Burai, had tall plant height criteria. While the cultivar Sibagindit had the lowest plant height but had a moderate tiller number of 14.33 tillers per plant. The more number of tillers, the more productive tillers will be and the lower the plant height (Rahayu et al. 2016).

The West Sumatra upland rice cultivars had days to flowering dan days to maturity from, respectively, 73.67 to 126.67 DAP and 111.67 to 157.33 DAP. Only Anam Ampek, Buyar, Cupak, Silampung, Sikuriak, Sikuriak basunguik, Silampung 2, and Sibagindit that performed earlier days to flowering or days to maturity than the check varity Jatiluhur. In a different place, Syahril (2017) also reported days to flowering and days to maturity in seven local upland rice cultivars in East Aceh ranging from 101 to 123 DAP and 148 to 176 DAP. Days to flowering were influenced by the plant's genetic nature and environmental condition. Meanwhile, maturity is influenced by flowering date, genetics, environment, and weather (Suroso and Sodik 2016). Early flowering and maturity on local cultivars are highly preferred (Mau et al. 2017). In this study, four cultivars, i.e. Buyar, Silampung, Sikuriak, and Sikuriak Basunguik were consistently earlier or similar in flowering and maturity dates. Early maturity in rice is crucial due to the possibility of increasing the planting index to increase annual production.

The local upland rice cultivars revealed a lower grain yield (15.95 g) than the check variety (17.25 g). Only Buyar cultivar showed a heavier grain yield (30.39 g) than a check variety Jatiluhur. Two cultivars (Silampung 2 and Sirah Kualo) had lower grain yields per-plant, and others had a similar grain yield per plant. Mau et al. (2017) reported 12.1-28.1 g grain yield per plant in red and black upland rice accessions from East Nusa Tenggara. Grain yield per plant is influenced by panicle length, grains per panicle, and the number of tillers. Suryanugraha et al. (2017) reported that the weight of 100 grains, panicle length, productive tillers, total tillers, number of filled grains per panicle, total grain number, and panicle density affected the actual production yield.

In conclusion, of the 28 local upland rice cultivars of West Sumatra, five cultivars had the same or better performance than the check variety tested, i.e. Anam Ampek, Buyar, Silampung, Sikuriak, and Sikuriak Basunguik. Buyar cultivar was the best based on grain yield (30.39 g). Plant height, the number of tillers, days to flowering, and days to maturity revealed high to moderately high GCV values and high heritability estimates. The number of tillers and days to maturity could be chosen as criteria selection for grain yield. Both traits performed high heritability estimates and significant genotypic correlation with grain yield.

ACKNOWLEDGEMENTS

We thank the Directorate General of Higher Education, Ministry of Research, Technology, and Higher Education of the Republic of Indonesia and LPPM Andalas University for the Magister Research Grant on behalf of the fifth author with contract no. T/53/UN.16.17/PT.01.03/PTM-Pangan/2020.

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