

cek plagiasi GIP/Mustikarini et  
al\_2020\_IOP\_Conf.\_Ser.\_Earth\_Environ  
\_Sci.\_497\_012002.pdf  
*By* Gigih Prayoga

PAPER · OPEN ACCESS

## Genetic parameters of $F_4$ red rice lines from landrace x national varieties hybridization

4

To cite this article: E D Mustikarini *et al* 2020 *IOP Conf. Ser.: Earth Environ. Sci.* **497** 012002

View the [article online](#) for updates and enhancements.

## Genetic parameters of F<sub>4</sub> red rice lines from landrace x national varieties hybridization

E D Mustikarini<sup>1\*</sup>, G I Prayoga<sup>1</sup>, R Santi<sup>1</sup>, and I Aditya<sup>1</sup>

<sup>1</sup>Department of Agrotechnology, University of Bangka Belitung, Jl. Raya Balunijuk, Gedung Semangat, Kampus Terpadu UBB, Balunijuk, 33172, Indonesia

E-mail: eriesdyah@yahoo.com

**Abstract.** Efforts that can be made in dealing with the limiting factors of rice plants are developing local rice to get the desired character. The results of hybridization were selected to see the superior character of the offspring based on genetic parameters. The purpose of this study was to obtain the value of variability, heritability, and expected genetic advance in each 4th generation character [F<sub>4</sub>]. Another goal was as a selection criterion for the 4th generation [F<sub>4</sub>] line and to get a line of promising that can be used as the next generation of promising lines. The research activities were carried out in the Experimental Station of the Department of Agrotechnology, Faculty of Agriculture, Fisheries and Biology, Bangka Belitung University. This research employed an experimental method based on a single plant design with a single factor that was 56 4th generation [F<sub>4</sub>] lines of crossed upland rice and 4 crossing elders. Qualitative characters were analyzed by calculating the modus of the characteristics of the whole population. Quantitative characters were analyzed by calculating variability, heritability, expected genetic advance, and t-student tests. The results showed that the character of flowering time, harvest time, and plant height had narrow variability, high heritability, and high expected genetic advance. The characters used for the selection criteria of rice plants in the 4th generation [F<sub>4</sub>] were flowering time, harvest time, and plant height. As many as 70 lines were used as the next generation of promising lines [F<sub>5</sub>].

### 1. Introduction

Indonesia is currently not able to meet the rice need of its population. International rice production in 2017 reached 758.9 million kg [1]. The biggest rice production in Asia is China with 208.4 million kg. Indonesia ranks third with a production level of 72.7 million kg. According to BPS data [2], Bangka Belitung in 2015 produced 18,951 tons of rice. Indonesia imported 256.6 thousand tons of rice in 2017 according to Indonesian CNN data [3].

Reduced the number of rice fields in Indonesia has been the main cause of the decrease in rice production. According to Badan Pusat Statistik [4], a decrease of around 24,000 ha rice fields in 2015 had made the total production area only remained 8,111,593 ha. The decline in rice production is also due to extreme environmental conditions. The limiting factors for rice production in Ultisol fields are CEC clay and low Org-C. Low Ultisol soil fertility inhibits growth and decreases the productivity of upland rice [5] [6].

One of the efforts to overcome the decline in rice production is to utilize local rice [germplasm]. Local rice has an adaptive characteristic in extreme environments, but its production is low. According to Mulyaningsih and Indrayani [7], local rice from Banten is resistant to aluminum stress on Ultis soils. According to Arinta and Lubis [8], the productivity of local Kalimantan rice cultivars is 3.86 to



5.18 tons/ha. The local rice plant of Bangka has a plant height of more than 100 cm [9]. According to Rusdiansyah *et al.* [10], all East Kalimantan local accession rice plants such as Kambang, Roti, Popot, Sikin Putih, Sikin Merah, and Pudak have a harvest age of more than 120 days.

Genetic improvement can be done by crossing superior rice with local rice varieties. Rice varieties as Inpari 10, Inpari 1 and Inpari 6 have high production potential compared to local rice. Inpari 10 rice production is 7.1 tons/ha [11], Inpari 1 rice production is 10 tons/ha, and Inpari 6 rice production is 12 tons/ha [12]. Rice varieties also have early maturity. Upland rice varieties have a harvest age of 108-115 days [13] and lowland rice varieties have a harvest age of 113 days [11].

Strain selection is an important step in plant breeding after the hybridization process. Variability, heritability, and expected genetic progress are important genetic parameters in plant breeding programs. Variability and heritability are the standards in continuing selection [14]. Extensive genetic variability is a prerequisite for effective selection programs [15]. According to Widyawati *et al.* [16], heritability is the influence of diversity that occurs in plants due to genetics or the environment. High heritability values indicate that the appearing diversity is more influenced by genetic factors [17], while low heritability values indicate greater environmental influence [18]. Successful selection can be in the form of high expected genetic advance and heritability in each generation [19].

This study aimed to obtain a superior 4th generation [F<sub>4</sub>] strain based on genetic parameter values. The main characters are lodging resistance, early maturity, and high yield potential.

## 2. Materials and Methods

The study was conducted from January to June 2019. The research site was in the Ultisol field of the Research Station of Bangka Belitung University in Bangka. The object of the study was 56 of 4th generation [F<sub>4</sub>] lines of Balok Accession, MR1512 Mutant, Banyuasin Variety, and Inpago 8 Variety. The 56 4th generation [F<sub>4</sub>] lines were obtained from the crossing between Balok Accession with Inpago 8, Balok Accession with Banyuasin variety, Mutant MR1512 with Inpago 8, and Mutant with Banyuasin variety. The pedigree selection was carried out in 1680 lines in the F<sub>2</sub> and F<sub>3</sub> generations.

The study employed an experimental method. Rice was planted in single plant design. The design was without spatial planning [single plant] or design without repetition because the seeds used were still segregated. The experimental unit was in the form of a plot with a spacing of 25 cm x 25 cm and a plot size of 0.5 m x 3.75 m. The distance between plots was 0.5 meter and the distance between plots in the middle was 1 meter. Each plot consisted of 30 upland rice plants so the study had 1,800 plants in total.

The selection was done by observing the whole plant. The population of each plot was 30 plants. The characters observed by the Agriculture Ministry of Republic Indonesia [20]. Quantitative characters observed included flowering age, harvest age, plant height, number of grains per clump, and grain weight per clump. Observation of plants and seed height was carried out at harvest time.

Data were analyzed by taking the results of the best strain modification of the quantitative characters observed as a whole. Quantitative characters were analyzed by calculating variability, heritability, and genetic progress.

Calculating variability begins with finding the value of genotypic variation, environmental variability, and phenotypic variation. The next step was to calculate the Genotypic Coefficient of Variation [GCV] and Phenotypic Coefficient of Variation [PCV]. The PCV and GCV were calculated following the procedures suggested by Nur *et al.* [21], thus

$$\%PCV = \left[ \frac{(\sigma_p^2)^{1/2}}{\bar{x}} \right] \times 100\% \text{ where } \sigma_p^2 = \frac{1}{N} \left[ \sum_{i=1}^N (xi - \mu)^2 \right]$$

$$\%GCV = \left[ \frac{(\sigma_g^2)^{1/2}}{\bar{x}} \right] \times 100\% \text{ where } \sigma_g^2 = \sigma_p^2 - \sigma_e^2 \text{ and } \sigma_e^2 = \frac{1}{n} (\sigma_{P1}^2 + \sigma_{P2}^2 + \dots + \sigma_{Pn}^2)$$

where,  $\bar{x}$  = grand mean of the character, xi = value of plant-i,  $\mu$  = mean of population, N = total of plant observed,  $\sigma^2$  = variance,  $\sigma_p^2$  = phenotypic variance,  $\sigma_g^2$  = genotypic variance,  $\sigma_e^2$  = environmental variance, Pn= check plant-n, n = total of check plant.

The analysis of the heritability [board sense] following the procedures suggested by Jameela *et al.* [17], and expected genetic advance by Widyawati *et al.* [16].

$$\text{Broad Sense Heritability [H]} = (\sigma^2_g) (\sigma^2_p)^{-1}$$

where,  $\sigma^2_p$  = phenotypic variance,  $\sigma^2_g$  = genotypic variance

The criteria of heritability value are [22] :

$0 \leq H < 0.20$ , Low;  $0.20 \leq H \leq 0.50$ , Moderate;  $0.50 < H \leq 1.00$ , High

Expected Genetic Advance [EGA] = [GA]  $[\mu]^{-1} \times 100\%$  where GA = i. H.  $\sigma_p$

where, GA = genetic advance, i = selection intensity [the value is 1.76 at 10%], H = broad sense heritability,  $\sigma_p$  = phenotypic standard deviation,  $\mu$  = mean of population.

The criteria of EGA value are :

$0 < \text{EGA} < 3.3\%$  = low  
 $3.3\% < \text{EGA} < 6.6\%$  = quite low  
 $6.6\% < \text{EGA} < 10\%$  = quite high  
 $\text{EGA} > 10\%$  = high

### 3. Results and Discussion

Selection of 1680 F<sub>4</sub> lines of local accession rice and national varieties resistant to lodging had been carried out. This study was conducted by observing quantitative characters including flowering time, harvest time, plant height, number of grains, and weight of grain. Each character was used to determine the variation level of phenotypes and genotypes. The calculation included phenotypic and genotypic variation, followed by the calculation of the Phenotypic and Genotypic Coefficient of Variation [Table 1].

21 Table 1. Estimates of mean, phenotypic and genetic variability parameters.

Parameters	$\bar{x}$	$\sigma^2_f$	$\sigma^2_g$	PCV [%]	Criteria	GCV [%]	Criteria
Flowering time	88.34	138.08	78.88	13.30	Narrow	10.05	Narrow
Harvest time	108.07	56.84	56.28	6.98	Narrow	6.94	Narrow
Height	76.23	125.18	49.32	14.68	Narrow	9.21	Narrow
Number of grains	579.00	226224	89025.02	82.15	Broad	51.53	Broad
Weight of grains	18.18	211.76	113.75	80.03	Broad	58.66	Broad

$\bar{x}$  = grand mean of population,  $\sigma^2_p$  = phenotypic variance,  $\sigma^2_g$  = genotypic variance, PCV = phenotypic coefficient of variation, GCV = genotypic coefficient of variation

The PCV and GCV criteria were adjusted to the results of the five characters. The highest percentage of PCV was 82.15% divided by four [4] criteria of narrow [0%≤21%], rather narrow [22%≤43%], quite broad [44%≤65%], and broad [66%≤87%]. The percentage of GCV was obtained by the same calculation as the percentage of PCV and the criteria were narrow [0%≤15%], rather narrow [16%≤30%], quite broad [31%≤45%], broad [46%≤60%]. Phenotypic Coefficient of Variation [PCV] and Genotypic Coefficient of Variation [GCV] on three [3] observational characters, namely flowering time, harvesting time, and p height all resulted in the narrow criterion with PCV and GCV value ranged from 6% to 14%. For the number of grains and weight of grains had a broad



criterion for both PCV and GCV, in which the PCV value for several grains was 80% and for the weight of grains was 82%, while the GCV value for several grains was 51% and for the weight of grains was 58% [Table 1].

The observed characteristics were a reference between lines that had a uniform characteristic. The coefficient of variance produced criteria confirming that the variation was due to the environment or genetic of the plant [23]. The flowering time, harvest time, and plant height all fell in the narrow criterion, both for the Phenotypic Coefficient of Variation [PCV] and Genotypic Coefficient of Variation [GCV]. This showed that the expected lines had a uniform characteristic. The PCV and GCV values were low, indicating the observed characteristics had narrow variation and uniform appearance [24]. The PCV and GCV values were low because the selection process had been done for a long time. The low PCV and GCV values in the fourth generation [F<sub>4</sub>] affected the next generation [F<sub>5</sub>] in which F<sub>5</sub> no longer needed to be selected because it had reached a uniform form [25]. Narrow variability indicates that the plants have uniformity in flowering time, harvest time, and plant height.

Plant height had reached its maximum size because it was classified as low to moderate in hopes of obtaining lodging resistant plants. Elders had a relatively high plant height category compared to their offspring; this became the benchmark that the produced lines had achieved good selection. Plant height can reach the desired stage by having an ideal plant height. Low plant height can provide a positive impact on the level of lodging. Plants will be more robust and able to withstand the damage caused by natural factors such as wind. The resulting lines can be classified as resistant crops [26].

The number of grains and weight of grains for both PCV and GCV fell in the broad criterion, these results indicated that the influence of the environment had made plants not uniform. Broad genetic diversity indicates opportunities for improvement in characteristics evaluated through selection [21]. The broad criterion for GCV indicated that each line has different potential, both in the number of grains and the weight of grains because the variation level in each line was not stable yet. The environment plays a role in influencing the characteristics [the number of grains and the weight of grains] that causes the potential yield to be different in each plant. Genetic factors will not display the traits they carry except in the presence of environmental factors required by the plant itself [27]. The environment influences the genes governing the number and weight of grains. The characteristic of the number and weight of grains has plural genes that allow the environment to influence the characteristic. The environment influences the appearance of gene expression that not all genes can express their traits in the number and weight of grains. Phenotypic variation refers to expressions influenced by genetics, environment, and interactions between the two [28]. The broad criterion of the number and weight of grains was a characteristic showing that the selection still needed to be done on the production characteristic. The heritability values for the five [5] observed characteristics fell in two [2] criteria, moderate and high. The heritability values for the number of grains and plant height were moderate. The other characters such as flowering time, harvest time, and weight of grains fell in the high criterion, with values ranged from 0.53 to 0.99 [Table 2].

**Table 2.** Estimates of heritability parameters

Parameters	Heritability [broad sense]	Criteria
Flowering time	0.57	High
Harvest time	0.99	High
Height	0.39	Moderate
Number of grains	0.39	Moderate
Weight of grains	0.53	High

Criteria: Low =  $0 \leq H < 0.20$ , Moderate =  $0.20 \leq H \leq 0.50$ , High =  $0.50 < H \leq 1.00$

Heritability values are the potential to determine that certain lines are dominantly influenced by the environment or genetics. High or low heritability is influenced by genotype variation and phenotypic variation. The estimated value of heritability shows the proportion of genetic influence on diversity

seen in the population compared to the influence of the environment [29]. The plant height characteristic had a moderate heritability criterion. The heritability value of the number of grains was 0.39. The plant height had increased because the plant height was uniform for each plant. As many as 1,155 plants had a height of 60 cm to 90 cm. [9] group plant heights into three [3], namely short [ $<90$  cm], medium [90-125 cm], and tall [ $>125$  cm]. The plant height characteristic had a uniform appearance due to the controlling gene of Sd1-Sd7. These genes allow plants to have a low plant height. The low plant height affects the level of rice lodging. Low plant height makes plants resistant to lodging [30].

Flowering time, harvest time, and weight of grains fell into the high category and the number of grains fell into the medium category. The high value of heritability was due to genetic influences giving positive values to offspring. According to [31], the heritability value close to 1 expresses high heritability and influence of genetic factors, while the heritability value close to 0 expresses low heritability and influence of environmental factors. The flowering time, harvest time, and grain weight are influenced by plant genetics. Plant genetics influence each characteristic to bring out good traits in individual plants. Flowering time and harvest time were probably influenced by the *Hd* gene; this allows plants to speed up the process of flowering and harvesting [32]. As many as 2,000 controlling genes that allow the plant to express better yields influence the grain weight. These genes influence the increase in crop production [33].

The expected genetic advance for all characteristics fell in the high criterion [Table 3]. The lowest EGA and %EGA was for plant height EGA value is used to determine inherited characteristics. The best individual plants were selected based on five [5] observational characteristics. The selection results were obtained by taking a selection intensity of 5%. The selection results obtained were 70 expected lines to be used in the next generation process. The lowest flowering time was 63 days after planting, the lowest harvest time was 91 days after planting, the plant height was 60 cm, the highest number of grains was 3,436, and the highest weight of grains was 91.6 grams. The line with the highest number of grains and weight was 23F-34-27 [27].

**Table 3.** Estimates of expected genetic advance [EGA] parameters

Parameters	Mean	GA	EGA [%]	Criteria
Flowering time	88.34	11.81	13.37	High
Harvest time	108.07	13.14	12.16	High
Height	76.23	7.76	10.18	High
Number of grains	579.00	329.42	56.90	High
Weight of grains	18.18	13.76	75.66	High

Criteria : Low =  $0 < EGA < 3.3\%$ , quite low =  $3.3\% < EGA < 6.6\%$ , quite high =  $6.6\% < EGA < 10\%$ , High =  $EGA > 10\%$

The Expected Genetic Advance [EGA] influences whether or not a selection continues. EGA is an important component in supporting successful selection. The high value of EGA affects the success of selection and the increase that occurs in offspring [34]. All characteristics, namely flowering time, harvest time, plant height, number of grains, and grain weight had a high EGA value. This shows that there was an increase in the offspring [16] and the success of the selection process. According to [35], the high value of EGA indicates that the character is supported by genetic factors, so it can facilitate the progress of the selection.

Plant height had a high EGA value. The plant height had reached its peak because the plant height had uniform EGA lines. Flowering time and harvest time had reached the early maturity criteria [7]; this means that further selection had to be stopped because it had reached the maximum stage. The number of grains [7] the weight of grains still needed to be selected to achieve uniform characteristics in each plant. The number of grains and weight of grains had a high EGA value but still had a wide variability.

Characteristics that have broad variability values need to be re-selected to obtain maximum results [36].

**Table 4.** The number of selected rice lines.

Number	Lines	Modus	Number	Lines	Modus
1	23F-34-27 (3)	3	36	23A-56-24 (4)	2
2	23F-34-27 (27)	3	37	23A-56-13 (28)	2
3	23A-56-24 (28)	3	38	09R-51-24 (1)	2
4	19I-06-09 (23)	3	39	21B-25-21 (28)	2
5	23F-34-20 (3)	3	40	21B-57-06 (17)	2
6	23F-34-27 (26)	3	41	23A-56-28 (24)	2
7	23F-34-16 (3)	2	42	23A-56-13 (7)	2
8	23F-34-16 (29)	2	43	23F-34-16 (1)	2
9	23A-56-11 (21)	2	44	23F-34-16 (11)	2
10	23A-56-28 (22)	2	45	23F-34-16 (18)	2
11	23A-56-11 (28)	2	46	23F-34-16 (21)	2
12	23F-34-16 (9)	2	47	23F-34-16 (30)	2
13	23A-56-11 (4)	2	48	23A-56-11 (1)	2
14	23A-56-11 (9)	2	49	23A-56-11 (24)	2
15	23A-56-11 (25)	2	50	23A-56-28 (15)	2
16	23F-34-16 (2)	2	51	23A-56-28 (27)	2
17	23A-56-28 (9)	2	52	23F-34-16 (6)	2
18	23A-56-28 (11)	2	53	23F-34-27 (1)	2
19	23A-56-28 (20)	2	54	23A-56-20 (28)	2
20	23A-56-28 (21)	2	55	21B-25-12 (25)	2
21	23F-34-11 (29)	2	56	21B-25-22 (16)	2
22	23F-34-16 (8)	2	57	21B-25-04 (29)	2
23	23F-34-16 (10)	2	58	23F-34-27 (11)	2
24	23F-34-16 (22)	2	59	21B-25-12 (6)	2
25	23F-34-16 (28)	2	60	21B-25-16 (24)	2
26	23A-56-28 (5)	2	61	21B-25-25 (5)	2
27	23A-56-28 (6)	2	62	21B-40-15 (3)	2
28	23A-56-28 (7)	2	63	21B-25-21 (2)	2
29	23A-56-28 (10)	2	64	19I-6-30 (20)	2
30	19I-06-16 (20)	2	65	21B-25-22 (24)	2
31	21B-57-06 (18)	2	66	23F-34-20 (2)	2
32	23A-56-24 (30)	2	67	21B-25-25 (28)	2
33	19I-06-09 (10)	2	68	21B-25-12 (2)	2
34	19I-06-18 (17)	2	69	19I-6-30 (22)	2
35	21B-57-04 (24)	2	70	23F-34-10 (18)	2

The best-expected lines were selected based on the highest number of modes in each line. The mode was obtained from the strains that often appeared in the 70 best lines of each characteristic. Mode calculation was done by adding up the total lines that appeared on the five [5] quantitative characteristics. As many as 70 lines were selected from the mode values that often appeared on the five [5] quantitative characteristics. 26 remaining lines were having a mode value of two [2]. Line codes having the most modes varied. However, most lines with 23F code appeared a lot. The 23F line was the result of a cross between Balok and Inpago 8 [Table 4].

The results of this study indicated that some expected criteria had been shown in several characteristics. These characteristics were short plant height [ $<90$  cm], flowering time and early harvest time [ $<105$  days after seedling]. However, some agronomic characteristics [production] such as several grains and the weight of grains still needed to be selected further to get stable results. Therefore, it is necessary to test the preliminary results on the population of the 5th generation [ $F_5$ ] lines.

#### 4. Conclusion



Flowering time and harvest time had narrow variability, high heritability, and high Expected Genetic Advance [EGA]. The characteristic used for rice selection in the 4th generation [F<sub>4</sub>] was the flowering time and harvest time. As many as 70 rice lines could be used as the next generation and the best line was 23F-34-27 [27].

## References

- [1] Food and Agriculture Organization of the United Nations 2017 *Rice Market Monitor* **20** 1-38
- [2] Badan Pusat Statistik 2018 Produksi Padi menurut provinsi <https://www.bps.go.id/dynamic/table/2015/09/09/865/produksi-padi-menurut-provinsi-ton-1993-2015.html> (12 September 2018)
- [3] Cable News Network Indonesia 2018 Tingkat Impor Indonesia 2018 [https://m.cnnindonesia.com/ekonomi/2018011517-95-269\\_054/statik-ekspor-impor-beras-indonesia](https://m.cnnindonesia.com/ekonomi/2018011517-95-269_054/statik-ekspor-impor-beras-indonesia) (10 December 2018)
- [4] Badan Pusat Statistik 2018 Luas Lahan Sawah Menurut Provinsi <https://www.bps.go.id/dynamic/table/2015/09/10/895/luas-lahan-sawah-menurut-provinsi-ha-2003-2015.html> (12 September 2018)
- [5] Waskito, Marpaung P, Lubis, A 2017 Evaluasi Kesesuaian Lahan Tanaman Padi Sawah, Padi Gogo (*Oryza sativa* L), dan Sorgum (*Shorgum bicolor*) di Kecamatan Sei Baman Kabupaten Serdang Bedagai *Jurnal Agroekoteknologi* **5** 226-232
- [6] Syahputra, Idwar, Tabrani G 2016 Respon Beberapa Varietas Padi Gogo (*Oryza sativa* L.) Ditanam di Tanah Ultisol Terhadap Amelioran *JOM Faperta* **3** 1-11
- [7] Mulyaningsih ES, Indrayani S 2014 Keragaman Morfologi dan Genetik Padi Gogo Lokal Asal Banten *Jurnal Biologi Indonesia* **10** 119-128
- [8] Arinta K, Lubis K 2018 Pertumbuhan dan Produksi beberapa Kultivar Padi Lokal Kalimantan *Bul. Agrohorti* **6** 270-280
- [9] Prayoga GI, Mustikarini ED, Pradika D 2017 Seleksi Aksesori Padi Lokal Bangka Melalui Pengujian Variabilitas dan Heritabilitas *AGROSAINSTEK: Jurnal Ilmu dan Teknologi Pertanian* **1** 56-67
- [10] Rusdiansyah, Subiono T, Saleh M 2015 Seleksi Lanjutan Kultivar Padi Sawah Lokal Kalimantan Timur *Jurnal Agrifor*. **14** 103-112
- [11] Yuniarti S, Kurniawati S 2015 Keragaman Pertumbuhan dan Hasil Varietas Unggul Baru (VUB) Padi Pada Lahan Sawah Irigasi di Kabupaten Pandeglang, Banten *Pros. Sem. Nas. Masy. Biodiv. Indon.* **1** 1666-1669
- [12] Suprihatno et al 2009 Deskripsi Varietas Padi Subang: Balai Besar Penelitian Tanaman Padi.
- [13] Bachtiar, Hasanudin, Hidayat T 2013 Identifikasi Beberapa Varietas Unggul Padi Gogo di Aceh Besar *Jurnal Agista* **17** 49-54
- [14] Sunarya S, Murdaningsih HK, Rostini N, Sumadi 2017 Variabilitas Genetik, Kemajuan Genetik dan Pola Kluster Populasi Tegakan Benih *Paraserianthes Falcataria* (L) Nielson Setelah Seleksi Massa Berdasarkan Marka Morfologi *Jurnal Kultivasi* **16** 279-286
- [15] Pangemanan V, Runtunuwu DS, Pongoh J 2013 Variabilitas Genetik dan Heritabilitas Karakter Morfologi Beberapa Genotipe Kentang *Eugenia* **19** 146-152
- [16] Widyawati Z, Yulianah I and Respatijarti 2014 Heritability and Genetic Gains of F<sub>2</sub> Population in Chili (*Capsicum annum* L.) *J. Produksi Tanaman* **2** 247-252
- [17] Jameela H, Sugiharto AN and Soegianto A 2014 Genetic Variability and Heritability of Yield Component Characters in F<sub>2</sub> Population of Common Bean (*Phaseolus vulgaris* L.) Derived from a Cross Between Introduced and Local Variety *J. Produksi Tanaman* **2** 324-329
- [18] Ismail A, Wicaksana N, Daulati Z 2015 Heritabilitas, Variabilitas Dan Analisis Keherabatan Genetik Pada 15 Genotip Pisang (*Musa paradisiaca*) Varietas Ambon Asal Jawa Barat Berdasarkan Karakter Morfologi Di Jatinangor *Jurnal Kultivasi* **14** 9-16
- [19] Barmawi M, Sa'diyah N, Yantama E 2013 Kemajuan Genetik dan Heritabilitas Karakter Agronomi Kedelai (*Glycine* (L) Merrill) Generasi F<sub>2</sub> Persilangan Wilis dan Mlg2521 *Prosiding Semirata FMIPA Universitas Lampung*: Lampung p77-82

- [20] Departemen Pertanian 2003 Panduan Sistem Karakterisasi dan Evaluasi Tanaman Padi Bogor: Sekretariat Komisi Nasional Plasma Nutfah.
- [21] Nur A, Iriany NR and Takdir A M 2013 Genetic Variability and Heritability of Agronomic Characters of Maize Inbred Line with Tester 14 *J. Agroteknos* **3** 34–40
- [22] Aryana I G PM Test of Uniformity, Heritability and Genetic Gain of Red Rice Obtained from Back Cross Selection in a Dryland Environment 2010 *J. Crop Agro* **3** 13–20
- [23] Istianingrum P, Damanhuri 2016 Keragaman dan Heritabilitas Sembilan Genotip Tomat (*Lycopersicum esculentum* Mill.) Pada Budidaya Organik *Jur. Agroekotek* **8** 70-81
- [24] Asadi, Dewi N 2016 Daya Hasil, Heritabilitas, Variabilitas Galur M6 Kedelai di Dataran Rendah dan Sedang *Prosiding Seminar Hasil Penelitian Tanaman Aneka Kacang dan Umbi: Bogor* p50-58
- [25] Widyayanti S, Basunanda P, Mitrowihardjo S, Kristantini 2017 Keragaman Genetik dan Heritabilitas Karakter Agronomi Galur F4 Padi Beras Hitam *Penelitian Pertanian Tanaman Pangan* **1** 191-200
- [26] Assad M, Warda 2016 Identifikasi Varietas Unggul Baru dan Pengaruh Pemupukan Spesifik Lokasi Terhadap Hasil Padi dan Mutu Beras di Kabupaten Gorontalo *Jurnal Pengkajian dan Pengembangan Teknologi Pertanian* **19** 261-273
- [27] Syafi'ie MM, Damanhuri 2018 Uji Daya Hasil Pendahuluan Mutan (M7) Padi Merah (*Oryza nivara* L.) Pada Musim Penghujan *Jurnal Produksi Tanaman* **6** 1028-1033
- [28] Sunyoto, Octriana L, Budiayanti T 2014 Keragaman Penampilan Fenotip Enam Genotip Pepaya Hasil Persilangan *Widyariset* **17** 303-310
- [29] Hastuti NMD, Yulianah I, Saptadi D. 2016. Heritabilitas dan Kemajuan Genetik Harapan 7 Famili Populasi F3 Hasil Persilangan Cabai Besar (*Capsicum annum* L) TW 2 x PBC 473. *Jurnal Produksi Tanaman* 4(1): 63-72
- [30] Mustikarini ED, Prayoga GI, Gati ED 2017 Early Population Development of Red Rice For Lodging Resistance *Proceeding Of PERIPI-2017 International Seminar October 2nd* Bogor p101-112
- [31] Effendy, Respatijarti, Waluyo B 2018 Keragaman Genetik dan Heritabilitas Karakter Komponen Hasil dan Hasil Ciplukan (*Physolis* Sp) *Jurnal Agro* **5** 30-38
- [32] Dadang A, Tasliah, Prasetyono J 2013 Seleksi dan Konfirmasi Alel Gen-Gen Hd Pada Padi Berumur Genjah dan Produktivitas Tinggi Persilangan Code x Nipponbare *Jurnal AgroBiogen* **9** 11-18
- [33] Mustikarini ED 2016 Adaptation of Red Rice Rice Mutants and Upland Rice Varieties in the Three Sub-Optimal Lands in Indonesia *J. Lahan Suboptimal* **5** 17–25.
- [34] Rohmatin A, Soetopo L, Respatijarti 2018 Pendugaan Nilai Heritabilitas dan Kemajuan Genetik Harapan Populasi F5 Pada Tanaman Cabai Besar (*Capsicum annum* L.) *Jurnal Produksi Tanaman* **6** 364-372
- [35] Kristantini, Sutarno, Wiranti E W and Setyorini W 2016 Genetic Advance and Heritability of Agronomic Characters of Black Rice in F<sub>2</sub> Population *J. Penelitian Pertanian Tanaman Pangan* **35** 119–124
- [36] Astari RP, Rosmayati, Basyuni M 2016 Kemajuan Genetik, Heritabilitas, dan Korelasi Beberapa Karakter Agronomis Progeni Kedelai F<sub>3</sub> Persilangan Anjasmoro Dengan Genotipe Tahan Salin *Jurnal Pertanian Tropik* **3** 52-61

### Acknowledgments

Our gratitude goes to the Ministry of Research, Technology and Higher Education of the Republic of Indonesia for the Applied Research Grant in 2019 that funded this study, and then we also thank the Institute for Community Service Research and Bangka Belitung University.

15%

SIMILARITY INDEX

---

PRIMARY SOURCES

---

- 1** E Swasti, D Hikma, H Wahyuni, N E Putri. "Gene action that controlling some characters on F2 generation derived from the crossing of Silopuk red rice with Fatmawati superior variety", IOP Conference Series: Earth and Environmental Science, 2020  
Crossref 176 words — 5%
- 2** [pure.aber.ac.uk](http://pure.aber.ac.uk)  
Internet 50 words — 1%
- 3** [krishikosh.egranth.ac.in](http://krishikosh.egranth.ac.in)  
Internet 32 words — 1%
- 4** [shura.shu.ac.uk](http://shura.shu.ac.uk)  
Internet 32 words — 1%
- 5** Gigih Ibnu Prayoga, Eries Dyah Mustikarini, Desti Pradika. "Selection of Bangka Local Rice Accession by Variability and Heritability Test", AGROSAINSTEK: Jurnal Ilmu dan Teknologi Pertanian, 2017  
Crossref 26 words — 1%
- 6** [scialert.net](http://scialert.net)  
Internet 24 words — 1%
- 7** "Sheepgrass (Leymus chinensis): An Environmentally Friendly Native Grass for Animals", Springer Science and Business Media LLC, 2019  
Crossref 22 words — 1%
- 8** A. A. Abd El Rahman, K. H. Batanouny, Nadia H. Ezzat. "Effect of

water supply on growth and yield of barley", Plant and Soil, 1967

Crossref

17 words — < 1 %

9 [media.neliti.com](http://media.neliti.com)

Internet

16 words — < 1 %

10 [es.scribd.com](http://es.scribd.com)

Internet

16 words — < 1 %

11 S. E. Diwakar Reddy, P. Jayamani. " Genetic diversity in land races of pigeonpea ( (L.) Millsp.) ", Electronic Journal of Plant Breeding, 2019

Crossref

14 words — < 1 %

12 [sabraojournal.org](http://sabraojournal.org)

Internet

14 words — < 1 %

13 Yusuff Oladosu, M. Y. Rafii, Norhani Abdullah, Mohammad Abdul Malek et al. "Genetic Variability and Selection Criteria in Rice Mutant Lines as Revealed by Quantitative Traits", The Scientific World Journal, 2014

Crossref

14 words — < 1 %

14 Sahri Yono, Reny Herawati, Hesti Pujiwati. "Genetic Diversity and Agromorphological Characteristics of 50 Upland Rice Genotypes Derived from Recurrent Selection", Akta Agrosia, 2018

Crossref

13 words — < 1 %

15 [dspace.vutbr.cz](http://dspace.vutbr.cz)

Internet

12 words — < 1 %

16 Fahim Ahmed, Mohd. Y. Rafii, Mohd. Razi Ismail, Abdul Shukor Juraimi et al. " The addition of submergence-tolerant gene into high yielding MR219 rice variety and analysis of its BC F population in terms of yield and yield contributing characters to select advance lines as a variety ", Biotechnology & Biotechnological Equipment, 2016

Crossref

10 words — < 1 %

- 
- 17 Sontosh C. Chanda, M. Sabibul Haque, A. K. M. Golam Sarwar, M. Nuruzzaman, M. Amir Hossain. "Genetic Dissection in Morphological Traits of Sesbania Genotypes", Proceedings of the National Academy of Sciences, India Section B: Biological Sciences, 2020  
Crossref 8 words — < 1%
- 
- 18 Ghimire, Bikal, Deepika Timsina, and Jyotsna Nepal. "Analysis of chlorophyll content and its correlation with yield attributing traits on early varieties of maize (*Zea mays* L.)", Journal of Maize Research and Development, 2015.  
Crossref 8 words — < 1%
- 
- 19 Nilahayati, Rosmayati, D S Hanafiah, F Harahap. "Genetic variability and heritability on Kipas Putih soybean mutant lines using gamma rays irradiation (M3 generation)", IOP Conference Series: Earth and Environmental Science, 2018  
Crossref 8 words — < 1%
- 
- 20 [www.mdpi.com](http://www.mdpi.com)  
Internet 8 words — < 1%
- 
- 21 [cgspace.cgiar.org](http://cgspace.cgiar.org)  
Internet 8 words — < 1%
- 
- 22 Biswajit Mondal, Sumer Pal Singh, Dinesh Chandra Joshi. " DUS Characterization of Rice ( L.) Using Morphological Descriptors and Quality Parameters ", Outlook on Agriculture, 2014  
Crossref 7 words — < 1%
- 
- 23 [protan.studentjournal.ub.ac.id](http://protan.studentjournal.ub.ac.id)  
Internet 6 words — < 1%
- 
- 24 "Studies on genetic variability and response to selection for quantitative and qualitative traits over environments in brinjal (*Solanum melongena* L.)", ELECTRONIC JOURNAL OF PLANT BREEDING, 2020  
Crossref 6 words — < 1%
- 
- 25 Robooni Tumuhimbise, Rob Melis, Paul Shanahan. "Genetic



---

variation in cassava for postharvest physiological deterioration", Archives of Agronomy and Soil Science, 2015

Crossref

6 words — < 1 %

---

26 [repo.unand.ac.id](http://repo.unand.ac.id)  
Internet

6 words — < 1 %

---

EXCLUDE QUOTES      ON  
EXCLUDE                      ON  
BIBLIOGRAPHY

EXCLUDE MATCHES      OFF