Uniformity test of the upland rice lines F8 from crosses of local Bangka rice and lodging resistance superior varieties in Belitung Regency

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Uniformity test of the upland rice lines F$_8$ from crosses of local Bangka rice and lodging resistance superior varieties in Belitung Regency

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Abstract. Lodging on plant rice can lead to reduces yields. Developing rice varieties with lodging resistance can do through the breeding activities. Crossing between local Bangka rice and lodging resistance superior varieties have been carried out and obtained F$_8$ lines of upland rice. Before releasing the rice lines released into varieties, it must meet the high uniformity criteria. This research aims to determine the uniformity level of F$_8$ upland rice lines. This research was conducted using an experimental method. The design used a randomized block design with 10 treatments (5 F$_8$ lines and 5 comparison varieties). The F$_8$ lines used 19I-06-09-23-03, 21B-57-21-21-23, 23F-04-10-18-18, 23A-56-20-07-20 and 23A-56-22-20-05. The comparison varieties used i.e. Danau Gaung, Inpago 8, Inpago 12, Rindang and PBM UBB 1. The research data were analyzed using qualitative descriptive, variability test, uniformity test, and Least Significant Increase (LSI) test. The result showed that F$_8$ lines of upland rice had narrow genotypic and phenotypic variability values in all characters observed. The percentage of uniformity was obtained in the range between 93-100%. It shows that the F$_8$ lines had a high uniformity. F$_8$ lines of 19I-06-09-23-03, 21B-57-21-21-23, 23F-04-10-18-18, and 23A-56-20-07-20 showed 100% uniformity level in plant height, flag leaf length, panicle length, productive tillers number, and filled grains number. The result of LSI test obtained 23A-56-22-20-05 and 23A-56-20-07-20 lines are better than the comparison varieties.

1 Introduction

Rice is an important food crop for people worldwide [1]. Rice is the major food commodity in Indonesia [2]. Efforts to reduce rice imports can be carried out, one of which is through local rice plant breeding activities.

Bangka Belitung Islands Province has as many as 26 accessions of local rice that have been found [3]. According to Mustikarini et al [4], local rice has the advantage of being resistant to biotic and abiotic stress. [5] stated that in addition to having the advantages, local rice Bangka also has several disadvantages, including easy lodging, long harvest, and low

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yield [6]. The occurrence of strong winds and heavy rains increase the frequency of crop lodging.

Crossbreeding activities between local Bangka rice and varieties with lodging resistance have been carried out and obtained F_8 lines of upland rice. The upland rice plant lines have changed to the degree of variability over several generations. The test of lodging resistance rice has been carried out by obtained a second generation (F_2) that has broad variability values in the character of the grain number, grain weight, plant height, and productive tillers number [3]. According to Mustikarini et al [7], the fourth generation (F_4) had a flowering time and harvest time with a narrow variability value. [8] continued research and obtained the sixth generation (F_6) resulting in a narrow genotype variability value in the character of plant height, leaf length, and seed weight for each plot. The results of the study of [9] in Bangka Island, obtained line F_7 of 23F-04-10-18-18 have high uniformity and yield production.

One of the conditions that must be met for a plant line to be released as a new superior variety is that the population in the line must be uniform. According to [10], uniformity indicates the degree of homogeneity in a plant. [11] stated that uniformity lines are of utmost importance in rice breeding. [12] stated that uniformity tests were carried out to ensure that the seeds of a plant variety had the characteristics of not deviating at the time they had been released as a variety. The level of plant uniformity can also be seen from the variability value. According to [13] variability is one of the genetic parameters that identify diversity in the population. [14] stated that low genetic diversity indicates that the rice genotype population has high uniformity. This research was conducted to determine the highest level of uniformity in several F_8 lines of upland rice. The results of this study are expected to obtain an F_8 line with high uniformity, which is required to release new high-yielding varieties.

2 Materials and methods

The materials used are 5 F_8 upland rice lines (19I-06-09-23-03, 21B-57-21-21-23, 23F-04-10-18-18, 23A-56-20-07-20 and 23A-56-22-20-05), and 5 comparative varieties i.e., Danau Gaung, Inpago 8, Inpago 12, Rindang, and PBM UBB 1. The research was conducted using an experimental method. The experimental design used was a Randomized Block Design (RBD) with 10 treatments (5 F_8 lines and 5 comparison varieties). Each treatments are divided into 3 different blocks with a total of 30 experimental units. The plot size was 4x5 m with 320 plants for each plot. The samples observed in each plot were 10 plants, bringing the total sample to 300 plants.

The observed characters are divided into qualitative and quantitative characters. Qualitative characters include the lodging index, leaf surface texture, leaf color, leg color, stem color, rice epidermis color, and rice shape. Quantitative characters include plant height, productive tillers number, flag leaf length, flowering age, panicle length, harvest age, filled grains number, and filled grains number for each plot. Qualitative data are analyzed descriptively and presented in the form of tables and figures. Quantitative data were analyzed using the ANOVA with a 95% confidence level followed by variability testing, uniformity test, and Least Significant Increase (LSI) test. The variability value can be calculated by analyzing the middle-squared variant first, then calculating the value of the genetic, environmental, and phenotype variant or variety.

3 Result and discussion

Table 1. Qualitative character of lines F$_8$ of upland rice plant.

Genotype	Leaf color	Stem color	Leg Color	Rice Epidermis Color	Rice Shape	Leaf Surface Texture	Lodging Index (%)
19I-06-09-23-03	Green	Green	Green	White	Slim	Medium hair	0
21B-57-21-21-23	Green	Green	Green	White	Slim	Hairy	0
23F-04-10-18-18	Purple on the Edges	Green	Green	White	Medium	Medium hair	0
23A-56-20-07-20	Green	Green	Green	White	Medium	Hairless	0
23A-56-22-20-05	Dark Green	Green	Green	Red	Medium	Medium hair	0
Rindang	Green	Green	Green	White	Medium	Hairy	0
PBM UBB 1	Dark Green	Green	Purple	Red	Slim	Hairy	91.14%
Danau Gaung	Green	Green	Green	White	Slim	Medium hair	76.25%
Inpago 8	Green	Green	Purple	White	Slim	Medium hair	0
Inpago 12	Green	Green	Green	White	Medium	Medium hair	0

The upland rice genotype has kinds of colors is leaf, stem, leg, and epidermis. The shape upland rice genotype rice has two kinds of shapes, namely slender and medium (Figure 1). The surface texture of upland rice genotype leaves has 3 kinds of textures. The upland F$_8$ rice line has the same lodging index of 0% or is very resistant to lodge. The PBM UBB 1 and Danau Gaung variety has lodging index including sensitive plants (Table 1).
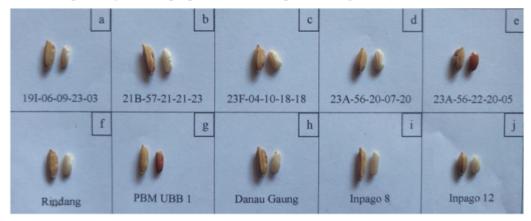

Fig. 1. Grain shape of 10 rice genotypes.

The F$_8$ lines of upland rice had narrow genotype and phenotype variability values in all characters (Table 2). The narrow variability value indicates that all the characters tested in the F$_8$ generation have had high uniformity. [15] stated that uniformity testing is determined by the magnitude of the variation that occurs in a population, the smaller the variation, the higher the uniformity and conversely. [16] stated that homogeneity in the observations made showed that the population has been uniform. According to [17], if the character of the tested line shows uniformity, it can be assumed that the character in the line is stable.

Table 2. Variability value of upland rice F_8 line.

Quantitative Character	Genotypic			Phenotypic		
	σ^2g	2 ($\sigma \sigma^2g$)	Criteria	σ^2f	2 ($\sigma \sigma^2f$)	Criteria
Plant height	258.62	304.14	Narrow	263.36	304.11	Narrow
Flag leaf length	2.90	4.89	Narrow	4.13	4.77	Narrow
Panicle length	0.38	1.60	Narrow	1.23	1.42	Narrow
Productive tillers number	28.90	34.38	Narrow	29.76	34.37	Narrow
Filled grain number	28090.90	36415.20	Narrow	31430.20	36292.50	Narrow
Filled grain weight	0.71	0.92	Narrow	0.80	0.92	Narrow
Flowering age	12.03	14.59	Narrow	12.63	14.58	Narrow
Harvest age	8.03	10.49	Narrow	9.05	10.45	Narrow

Note : "Genotypic variability" $\sigma^2g \geq 2 (\sigma \sigma^2g)$ = wide, $\sigma^2g < 2 (\sigma \sigma^2g)$ = narrow; "Phenotypic variability" $\sigma^2f \geq 2 (\sigma \sigma^2f)$ = wide, $\sigma^2f < 2 (\sigma \sigma^2f)$ = narrow.

The range of uniformity percentages in the F_8 lines tested was 83.3-100%. Lines is indicating characters have 100% uniformity. Line 23A-56-22-20-05 has 5 uniform characters, namely plant height, flag leaf length, panicle length, filled grain number, and the filled grain weight for each plot, a non-uniform character of the productive tillers number (Table 3). [18] stated that self-pollinating plants will experience an increase in homozygosity. Generation F_8 is the 7th generation of segregation, the homozygous percentage is 99.21%. [15] stated that a plant is considered uniform if the properties possessed remain the same even though it is planted in different environments. [19] stated that genotypes with a uniform character mean that selection activities in these characters no longer need to be selected, because the phenotype of these characters is already consistent.

The plant height of lines is shorter than the plant height of the comparator varieties subtracted LSI value (Table 4). Line 23A-56-20-07-20 has a lower plant height than Danau Gaung and PBM UBB 1. According to [20], the height of upland rice plants is classified into short (<90 cm). [21] stated that plant height is the main factor causing lodging in plants. [22] stated, that the higher the plant, the higher the tendency to fall. [6] stated that strong winds and high rainfall can cause a fall in rice plants. The Danau Gaung variety experienced a lodging of 76.25% and the PBM UBB 1 variety experienced a lodging of 91.14%, resulting in yield loss due to the large number of vacuous seeds produced. [23] stated that Lodging in rice often limits grain yield and quality.

Table 3. Uniformity of F_8 lines.

Genotype	Plant height		Flag leaf length		Panicle length		Productive tiller number		Filled grain number		Filled grain weight		% uniformity
	sd	Ket	sd	Ket	sd	Ket	sd	Ket	Sd	Ket	sd	Ket	
19I-06-09-23-03	4,27	U	1,67	U	1,38	U	1,83	U	161,82	U	0,54	U	100%
21B-57-21-21-23	11,08	U	2,62	U	2,12	U	1,59	U	156,80	U	0,18	U	100%
23F-04-10-18-18	12,79	U	2,38	U	1,61	U	0,35	U	128,47	U	0,19	U	100%
23A-56-20-07-20	3,18	U	1,15	U	0,58	U	1,90	U	106,70	U	0,57	U	100%
23A-56-22-20-05	3,47	U	0,94	U	0,69	U	3,41	NU	133,82	U	0,62	U	83,3%
Rindang	14,73		3,56		2,14		2,62		203,66		0,30		
PBM UBB 1	2,98		2,07		0,97		1,94		146,56		0,98		
Danau Gaung	2,55		1,64		1,24		1,05		123,02		1,59		
Inpago 8	21,69		4,87		3,71		1,45		191,99		1,58		

Inpago 12	2,83		0,99		0,92		2,24		212,02		3,57	
sd Comparison varieties	26,01		7,27		3,28		2,30		375,64		1,88	

Note : 1. SD value < sd comparator = uniform (U), sd value > sd comparator = non-uniform (NU). 2. Comparative varieties are: Danau Gaung, Rindang, PBM UBB 1, Inpago 8, Inpago 12

The character of the number of productive saplings of the F_8 line ranges from 10.76-24.30 tillers. There is 1 line of offspring that has more productive tillers than the comparison variety, namely line 23A-56-22-20-05. [24] stated that the number of productive tillers in planting is one of the important things related to the grain yield of rice plants. According to [25], to increase grain yield, a genotype must have a greater number of tillers. Reinforced by the opinion of [26] productive tiller number of a rice plant is related to panicle number. The greater the number of tillers and panicles produced by rice plants, the more grain produced by rice plants will also be.

Table 4. Result of LSI test.

Genotypes	Plant height (cm)	Flag leaf length (cm)	Panicle length (cm)	Productive tiller number	Filled grain number	Filled grain weight (kg)	Flowering age (DAP)	Harvest age (DAP)
19I-06-09-23-03	97,22abcdef	24,10	18,64	12,70	665,90	6,61acd	72,00cd	107,66acd
21B-57-21-21-23	110,34abcde	24,50	19,91	12,12	477,83	4,70	77,66d	112,66d
23A-56-20-07-20	132,13ad	26,65	20,67	13,80	836,43	6,78acd	67,66abcdef	104,66acdf
23A-56-22-20-05	89,36abcdef	21,06	17,90	4,30abcdef	761,00	6,72acd	72,00cd	107,00acd
23F-04-10-18-18	109,64abcdef	23,21	18,68	10,76	426,13	6,67acd	72,00cd	106,33acd
Danau Gaung + LSI (a)	144,97	38,88	28,15	13,75	1148,40	6,09	70,79	107,85
Inpago 12 + LSI (b)	112,44	31,18	24,58	17,39	1907,20	9,77	68,46	102,85
Inpago 8 + LSI (c)	121,20	36,09	27,66	15,50	1155,70	6,04	75,12	110,18
PBM UBB 1 + LSI (d)	164,27	49,61	29,89	16,15	1182,36	4,72	85,12	116,18
Rindang + LSI (e)	118,00	35,51	23,33	14,65	997,46	7,13	68,46	102,85
$\bar{X}$g + LSI (f)	110,33	32,38	24,12	17,85	1113,24	7,28	71,16	105,75
LSI	19,26	2,61	2,36	5,49	314,80	1,52	3,54	4,15

Note: The letters listed behind the numbers indicate that: a) better than Danau Gaung, (b) better than Inpago 12, (c) better than Inpago 8, (d) better than PBM UBB 1, (e) better than Rindang; The letter in parentheses is a symbol to indicate the check rice varieties; g = average value of F_8 lines; The test lines are better than the check plant when the value of lines ≥ the value of the check + LSI, except for plant height, flowering age, and harvest age is better when the value of lines ≤ the check value – LSI.

The character of the flag leaf length of the F_8 lines ranges from 21.06-26.65 cm. The longest flag leaf length is line 23A-56-20-07-20. The results of the LSI test showed that the length of the flag leaf of the F_8 line of upland rice was not better than the comparison varieties. [27] stated that the length of the flag leaf can be used as a potential phenotypic marker for high production yields. According to [28], flag leaf has a great effect on the yield of rice. [29] stated that flag leaves provide the most important source of photosynthetic energy during grain reproduction and filling.

The panicle length character of the F$_8$ lines of upland rice ranges from 17.90-20.67 cm. According to [20], panicles are five grouped. The data showed that the length of the panicle line F$_8$ belonged to the medium group. [30] stated panicle length will affect the amount of grain produced and affect the amount of yield.

The flowering age of the tested F$_8$ lines ranges from 67.6-77.6 days after planting. The harvest age range of the F$_8$ lines of upland rice is between 104.6-112.6 days after planting. [31] stated the timing of flowering is determined by endogenous genetic and environmental. According to [32], the flowering age is related to the harvest age. The age of the harvest is influenced by the speed of flowering plants, the faster the plant blooms, the faster the plants will harvest [33].

The character of the number of filled grains indicates that the F$_8$ line of upland rice is no better than the comparison varieties. According to [34] in addition to genetic factors, environmental factors also affect the number of filled grains of each panicle. [35], the ability of plants to produce the number of grains is also influenced by the number of tillers and the length of the panicles.

The weight of filled grains in each plot of the F$_8$ lines of upland rice ranges from 4.70-6.78 kg /plot. Grain filling rate is affected by external environmental conditions, pest and disease attacks [36]. According to [37], the weight of filled grains for each plot is also influenced by the genetics of the character of elders.

4 Conclusion

The upland rice line F$_8$ had a narrow genotypic and phenotypic variability value for all observed characters . The percentage of uniformity obtained is around 83.3-100%. It shows that the F$_8$ lines had a high uniformity. F$_8$ lines of 19I-06-09-23-03, 1B-57-21-21-23, 23F-04-10-18-18, and 23A-56-20-07-20 showed 100% uniformity level in plant height, flag leaf length, panicle length, productive tillers number, and filled grains number. The result of LSI test obtained 23A-56-22-20-05 and 23A-56-20-07-20 lines are better than the comparison varieties.

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