# Advanced Results Test of Upland Rice Lines 7th Generation ($F_7$) from Local Rice X Superior Varieties with Lodging Resistance in East Belitung Regency

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**ABSTRACT**

Plant breeding activities are one of the efforts that can be done to get rice with a high yield. Advanced yield test is one of the yield test stages to identify genotypes of upland rice that has the potential as a new superior variety with high yielding and lodging resistance. This study aims to obtain information about the Advanced yield of several 7th generation upland rice lines ($F_7$) from crossing between local rice with superior rice varieties in East Belitung Regency and obtain $F_7$ lines that can be recommended as candidates for superior varieties that have high yield for multilocation tests. The time and place of this study were carried out from December 2020 to May 2021 in Mentawak Village, Kelapa Kampit Subdistrict, East Belitung Regency. The study used experimental methods with randomized block design (RBD). Treatment consists of 5 $F_7$ of upland rice and 5 varieties as comparison. Data obtained will be analyzed by using the F test and continued with the Least Significant Increase (LSI) test. The results of this study are that there are 3 $F_7$ upland rice lines, namely 23F-04-10-18-18, 19I-06-09-23-03, and 21B-57-21-21-23 which is better than other $F_7$ lines. Line of 23F-04-10-18-18 is the best promising line because it has an advantage in some traits, lodging resistance, and and high yield. These traits were the number of pithy grains (grain), weight per clump (g), the weight of 1000 grains (g), and the weight of grains per plot (g).

***Keywords:*** *Advanced yield test, Upland rice, Superior varieties, Lodging resistance*

## 1. INTRODUCTION

The largest food commodity in Indonesia is rice because it is a staple food source for most of Indonesia's population. The demand for rice is increasing along with the increase in population, in 2019 the need for rice will increase by around 2.5 to 5 million tons per month [1]. This is a big challenge for various sectors including the agricultural sector. The challenge for Indonesian agriculture is the ability to meet the increasing demand for rice [2]. This is because rice is the daily staple food consumed by approximately 90% of the total population of Indonesia [3]. Progress in agriculture is very much needed to meet the high demand for food, especially in Indonesia.

Rice production in Indonesia fluctuates every year. Rice production in Indonesia in 2018 from January to December was 56.54 million tons. However, the numberof rice production produced is not sufficient for national needs, so the government imports rice from other countries. In 2017 the government imported 305.3 thousand tons of rice and 2.2 million tons in 2018 [1].

The low level of rice production is caused by various factors, one of which is abiotic factors. Abiotic factors that cause low rice production include strong winds and high rainfall. This can cause rice plants to lose yields as a result of restlessness. The percentage of loss caused by laying down is 11.89% [3]. Plants that are resistant to falls have a production percentage of 26% higher than plants that are not resistant to falling [4]. Lodging can also cause early harvesting of rice plants and low grain prices [5].

The problem of low rice production must be addressed immediately to reduce the number of food shortages and rice imports in the present and the future.


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Efforts that can be made are to use technology to create superior varieties [6]. Innovation of superior varieties is the key to the success of increasing Indonesian rice production [7]. This is because superior varieties can increase the potential or yield of plants and are resistant to biotic stresses, and are tolerant of abiotic stresses [8]. One of the breakthroughs that can be made to produce these superior varieties is by developing new varieties of local rice that are resistant to lodging.

The province of the Bangka Belitung Islands has some local rice, including Balok, Grintil, Balok Runti, Mayang Curui, Payak Tebing, Balok Lukan, Balok Lutong, and Mukud Besak. Bangka local rice is generally in the form of upland rice which has the advantage of being tolerant of biotic and abiotic stresses. However, the weaknesses of local Bangka rice include easy falling because of the height of > 100 cm, long life, low yield, and intolerant to drought [9]. One solution to overcome this weakness is by crossing local Bangka rice with national varieties that are resistant to lodging.

Crosses between local Bangka rice and fall-resistant varieties were carried out in 2017 and the 1st generation (F1) line was obtained. The selection will continue until the 7th generation (F7) is obtained [10]. Crossed rice plants need to be selected to get superior characters in their offspring. The 7th generation red rice line was obtained from the selection of the F 6 . line the results of crosses between local accessions and national varieties in 2020 to obtain rice plants that have high yield and fall resistance properties [11]. The parents used were beam accessions, M8-gr150-1-9-13, Inpago 8, and Banyuasin varieties. The hybridization activity resulted in the first offspring and the self-sufficient F1 generation using conventional selection and molecular markers of SSR [12]. Overall F2 lines were planted and 56 best lines were obtained as F3 lines [13]. The next generation of plants is replanted for further selection. The 4th generation obtained as many as 70 lines that can be used as lines of hope for the next generation [14]. The selection stages in the 5th generation obtained the 10 best generation lines to be used in the 6th generation (F 6) line selection. Preliminary yield test on In the 6th generation, the best 5 generations were obtained which will be used for the selection of the 7th generation (F7) lines [15]. The next step is to carry out an advanced yield test of the 7th generation (F7) to get a line that has properties against laying down and has high production.

The advanced yield test is one of the yield test stages to identify genotypes and obtain high-yielding upland rice that has the potential as a superior variety [16]. The results of the advanced yield test are in the form of prospective superior varieties that can be released after a multi-site test [17]. Therefore, it is necessary to carry out further yield tests on the F7 generation of cross-bred upland rice to obtain prospective lines of superior varieties that will be used in the multilocation test later.

The purpose of this study was to obtain information regarding the yield of several upland rice lines of the 7th generation (F7) resulting from crosses of local rice and high yielding varieties that are resistant to collapse in East Belitung and Obtain the F7 Line which can be recommended as a candidate for superior varieties that are resistant to fall and have high yields for multilocation tests.

## 2. MATERIALS AND METHODS

This research activity was carried out from January 2021 to June 2021. The activity was carried out in Mentawak Village, Kelapa Kampit District, East Belitung Regency. The tools used in the research activities were envelopes, ropes, wood, scissors, hoes, tractors, lawn machines, analytical scales, machetes, earthen forks, watering plants, ruler, sprayer, RHS Color Chart, tape measure, and stationery. The materials used are 5 rice hope lines selected at F7 (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 genotypes used were Banyuasin, Danau Gaung, Inpago 8, Inpago 12, and Rindang. Other materials used are fungicides, pesticides, manure, and chemical fertilizers. This research was conducted with the experimental method. The design used was a Randomized Block Design (RBD). The treatments consisted of 5 expected F7 lines of brown rice, and 5 comparison varieties. Each treatment level was repeated 3 times with a total of 30 experimental units. Each plot measuring 4 m x 5 m consists of 320 planting holes, with a total of 3 grains in each planting hole. The samples observed in each plot were 10 clumps so the total sample was 300 clumps.

### *2.1. Procedures*

Land preparation begins with land clearing activities measuring 46 m x 17 m by slashing and clearing weeds. Making beds measuring 4mx5m with a distance between beds of 0.5 meters. Land preparation is in the form of loosening the soil using a hoe. The grains to be planted are soaked and ripened for 24 hours each. The grains that give rise to the radicle are planted directly in a tugal manner. The number of grains per planting hole is 3 grains and an adequate numberof 3% carbofuran active insecticide is added. The spacing used is 25 cm × 25 cm, so there are 320 planting holes/beds. The fertilizers used are manure and inorganic fertilizers, namely Urea, TSP, and KCl. Manure was applied to the soil 1 week before planting at a dose of 10 tons/ha (20 kg/plot). The dose of urea fertilizer used was 150 kg/ha (300 g/plot) which was given gradually at the age of 20 DAP, 55 DAP, and 65 DAP each with 100 g/plot. Other inorganic fertilizers were TSP 100 kg/ha (200 g/plot) and KCl 75 kg/ha (150 g/plot) which were applied at 20 DAP. Fertilization is done by the spot placement method. Maintenance includes watering, replanting, weeding, and controlling pests and diseases. Watering of rice plants is carried out starting from the grain phase to harvesting which is carried out every day. Embroidery is done in the same planting hole do not grow no later than 14 DAP. Weeding is done around the planting media by pulling weeds mechanically which is done every 2 weeks. Pest and disease control is carried out every 3 days starting at 30 DAP according to the dosage rules for use. Harvesting was carried out at physiological maturity, i.e. 80% of the panicles had turned yellow in each plot. Harvesting is done by cutting the panicle from the base of the panicle. The harvested grain samples are then threshed manually and put into envelopes. Each envelope was marked with the genotype name and harvest date. The rest of the grain is put in sacks marked with the genotype name and harvest date. Drying is done in the sun for 2-3 days.

## 2.2. Observation Characters

This advanced yield test was carried out by observing 10 plant samples per plant plot. The characteristics of the rice plants observed were as follows: The height of the rice plant was measured from the soil surface to the tip of the longest panicle. Rice plants that have not issued panicles cannot be measured because the plant height covers the entire plant itself. Rice plants have leaves that are shaped like ribbons, besides that rice plants have a part called the flag leaf. The flag leaf in question is a leaf located in the leaf panicle or the highest leaf on the rice plant. Calculation of the number of tillers is done by counting productive tillers. How count the number of productive tillers of rice is done manually or count one by one productive tiller of rice in one clump that has grown in each sample of plants. This process was determined when 80% of the rice plants in the experimental plots flowered. The flowering age of the plant is calculated by counting the flowering days from the time the grains are planted until the plant's flower. Flowering age is determined on the first day of flowering plants. The tools used are stationery and a camera. Measure from the point of attachment of the lowest panicle branch to the tip of the center of the spike. Panicle length can be done on rice plants (*Oryza sativa* L.) that have entered the generative phase. Measurements were made using a writing instrument, a camera, and a 60 cm ruler. Determination of harvest age is determined when the panicles of rice plants 80%-85% have turned yellow.

The number of pithy grains was obtained by counting all the pithy grains in one clump per plot at the time of harvest. The pithy grains are separated from the empty grains by aerating or winnowing. Rice grains are harvested when the rice is physiologically ripe. Rice grains are harvested when the rice is physiologically ripe. Grains are harvested in plots and placed in a container. The empty grains are separated from the empty grains by aerating or winnowing. Then the empty grains were weighed using a digital scale. The grains were harvested in plots and placed in a container, then the grains were weighed using a digital scale. The number of grain obtained was calculated by counting all the number of grain in one clump of rice plants. The calculation is done at the time after harvest. The weight of 1000 grains of rice grains is known by counting the pithy grains up to 1000 and then weighing them. Observations were made after the grain was dried. Rice husk color The color of the husk of rice is known by observing the color of the pericarp in broken rice. Rice colors are grouped into 1. White; 2. light brown; 3. small brown spots; 4. Brown; 5. Red; 6. purple varies and 7. purple (IRRI 2011). Assessment of the laydown index is carried out after harvest. The assessment was carried out with the following indices of fall: (0) the plant did not fall (very resistant to fall); (1) less than 20% of plants fall (resistant to fall); (3) falling plants 21-40% (somewhat resistant to fall); (5) fallen plants 41-60% (medium); (7) fallen plants 61-80% (slightly sensitive) and (9) fallen plants above 80% (sensitive). The grain weight of the clump was obtained by weighing all the grains in one clump per plot at the time of harvest. Cluster grains were taken based on the sample plants for each plot. The number of plants that live is calculated based on the number of plants that live in one bed. The calculation is carried out at the time of harvesting the rice plant.

## 2.3. Data Analysis

Data analysis was carried out in this study on the observed characters of the entire treatment using Fisher's exact test (Analysis of Variance) with a 95% confidence level. Ruchjaniningsih and Muh (2013) stated that, if it had a significant effect, it would be carried out with the LSI (Least Significant Increase) test at 95% and 99% significant levels. The LSI test was carried out to compare the genotype diversity of the lines with the comparison genotypes. The LSI test formula is as follows.

$$LSI = t_{(0.05;df)} \sqrt{(2MSE/r)} \quad (1)$$

Information:

$t_{(0.05;df)}$ = Value of t table one way at α 0.05

MSE = Middle Square Error

r = Number of repetitions

## 3. RESULT

The results of the variance showed that the rice genotype had a very significant effect on all observed characters, except for the character of the number of productive tillers which had no significant effect (Table 1). The results of the variance that showed a very significant effect on the observed characters were further tested using the LSI (Least Significant Increase) test (Table 2). The character of the F7 plant height was better than the comparison variety because the F7 lines had a shorter height, namely the 19I-06-09-23-03 line, 21B-57-21-21-23, 23A-56-20-07-20, 23A-56-22-20-05 and 23F-04-10-18-18 compared to the comparison varieties, namely Danau Gaung, Inpago 12, Inpago 8, Rindang and Situ Patenggang. The morphology of the plant height can be seen in Figure 1.

**Table 1.** The results of the character variance in the generative phase.

| Character | F Count | Pr > F | KK% |
|---|---|---|---|
| Plant Height (cm) | 15.10 | <0.0001 * * | 8.01 |
| Flag Leaf Length (cm) | 14.51 | <0.0001* * | 10.53 |
| Number of productive tillers (saplings) | 2.23 | 0.0703 $^{ns}$ | 15.81 |
| Flowering Age (DAP) | 63.03 | <0.0001* * | 1.22 |
| Harvest Age (DAP) | 2.41 | <0.0001* * | 1.66 |
| Panicle Length (cm) | 14.26 | <0.0001* * | 5.21 |
| Grain Weight per plots (Grams) | 30.93 | <0.0001* * | 23.10 |
| Weight of Pithy Grains per plot (Gram) | 98.03 | <0.0001 ** | 20.70 |
| Empty grain Weight per plot (Gram) | 13.54 | <0.0001** | 35,10 |
| Weight 1000 Grains (Grams) | 10,17 | <0.0001* * | 14.42 |
| Number of Grains per panicle (Grain) | 15,10 | <0.0001* * | 14.42 |
| Clump Grain Weight (Gram) | 14.83 | <0.0001* * | 19.33 |
| Number of pithy grains (Grains) | 33.30 | <0.0001* * | 17.33 |
| Number of Live Plants (Plants) | 219.08 | <0.0001** | 8.26 |

Note:
CV = Coefficient of diversity
Pr > F = probability value
** = Significantly influential at α 0.01
ns = not significant

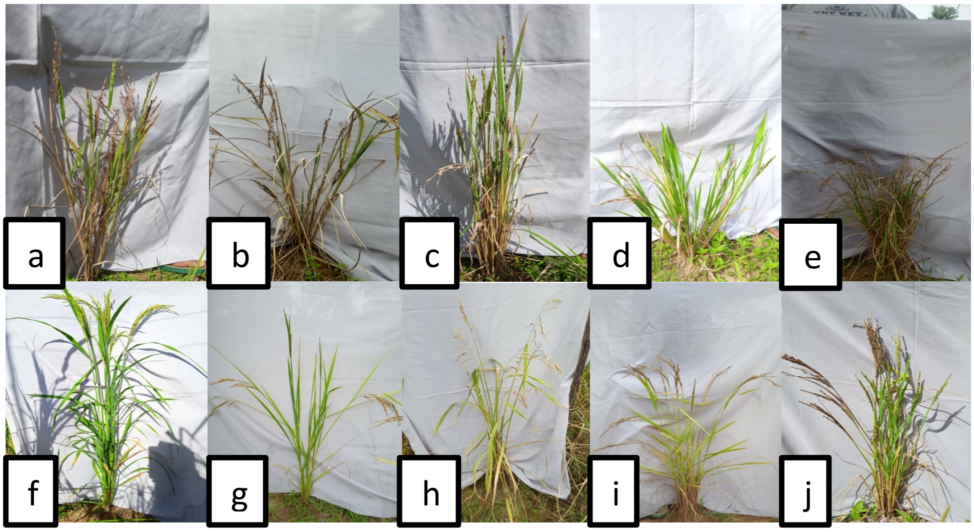


**Figure 1** Morphology of rice plants in lines (a) 23A-56-20-07-2, (b) 21B-57-21-21-23, (c) 23F-04-10-18-18, (d) 19I-06-09-23-03, (e) 23A-56-22-20-05, and comparison varieties (f) Danau Gaung, (g) Inpago 12, (h) Situ Patenggang, (i) Inpago 8, (j) Rindang

The LSI test results in Table 2 show that the plant height characters of all lines had a lower height than all of the comparison varieties. The test line with the lowest height was 19I-06-09-23-03 with a height of 82.14 cm, and the line with the highest height was 23F-04-10-18-18 with a height of 95.98 cm. The lineage was declared to be better than the comparison on the character of the length of the flag leaf if the flag leaf of the offspring line was longer than the parent or the comparison variety plus the LSI value. Table 2 shows that the length of the flag leaf of the 19I-06-09-23-03 line was better than the comparison varieties, except for the varieties of Danau Gaung and Situ Patenggang. The 23F-04-10-18-18 line had better flag leaf length than the comparison varieties, except for the Danau Gaung, Rindang, and Situ Patenggang varieties. Line 23F-04-10-18-18 in Table 2 showed better panicle length than the comparison variety, Inpago 12, while Line 19I-06-09-23-03, 21B-57-21-21-23, 23A- 56-20-07-20, and 23A-56-22-20-05 had short panicle lengths compared to all comparison varieties. The observed characteristics of harvesting age in Table 2 show that line 23A-56-20-07-20 has a faster harvest age than all comparison varieties except for the Situ Patenggang variety, while lines 21B-57-21-21-23 and 23F-04 -10-18-18 has a faster harvesting age than the comparison varieties except for Rindang and Inpago 12. The 23F-04-10-18-18 line has a better number of pithy grains than the comparison varieties except for the Situ patenggang, and Rindang varieties. The lines 19I-06-09-23-03 and 21B-57-21-21-23 had a better number of pithy grains compared to the comparison varieties of Danau Gaung and Inpago 12, while lines 23A-56-20-07-20 and 23A-56-22-20-05 had a better number of pithy grains than the Danau Gaung variety. Table 2 shows that Line 23A-56-22-20-05 has a better pithy and hollow grain weight character than all comparison varieties except for Rindang varieties, for Lines 21B-57-21-21-23 and 23F-04-10- 18-18 had better pithy and hollow grain weight than the comparison varieties of Danau Gaung, while Line 23A-56-20-07-20 and 19I-06-09-23-03 had lower pithy and hollow grain weight compared to all varieties. The observational character of the number of grains per panicle in Table 2 shows that the number of panicles in the F7 line was lower than all the comparison varieties. The lines 19I-06-09-23-03 and 23F-04-10-18-18 in Table 2 show that the grain weight of the pithy grain was better than the comparison varieties, Inpago 12, Inpago 8, and Danau Gaung, while line 23A-56 -22-20-05 has a better pithy grain weight than the comparison varieties of Danau Gaung and Inpago 12, Line 21B-57-21-21-23 has a lower pithy grain weight than the comparison varieties Inpago 12, and Line 23A- 56-20-07-20 had a lower pithy grain weight than all the comparison varieties. Table 2 shows that the line that had more clump weight than the comparison varieties of Danau Gaung and Inpago 12 was Line 23F-04-10-18-18, while the Line that had a better clump weight than the Danau Gaungwas Line 19I-06-09-23. -03 and 21B-57-21-21-23, lines 23A-56-22-20-05 and 23A-56-20-07-20 had lower clumping weights compared to the comparison varieties. Based on Table 2 on the observation character of 1000 grains, shows that the 23F-04-10-18-18 and 19I-06-09-23-03 lines weight 1000 grains which is better than the 1000 grains weight of all comparison varieties, while the 23A- 56-22-20-05 has a weight of 1000 grains which is better than the comparison varieties of Danau Gaung, Inpago 12, and

Situ Patenggang. Line 21B-57-21-21-23 had 1000 grain weight which was better than the comparison varieties of Danau Gaung and Situ Patenggang, while 23A-56-20-07-20 had 1000 grains lower weight than all comparison varieties. Lines 23A-56-20-07-20, 23A-56-22-20-05, and 23F-04-10-18-18 in Table 2 indicate that the observed character of empty grain weight is lower than the comparison variety Inpago 12, situ patenggang, Rindang, Inpago 8, and Danau Gaung, while the lines had better grain weight than the comparison varieties of Danau Gaung, and Inpago 12, Lines 21B-57-21-21-23 and 19I-06-09-23-03 had lower empty grains compared to the comparison varieties inpago 12, inpago 8 and situ patenggang. Figure 2 showed that the number of productive tillers was not significantly different, indicating that there was a line 19I-06-09-23-03 which tended to have a large number of productive tillers from all the comparison varieties. The lines 21B-57-21-21-23, 23A-56-20-07-20, 23A-56-22-20-05 had more productive tillers than the comparison varieties except for Rindang and Situ Patenggang. The 23F- 04-10-18-18 line had more productive tillers than the comparison varieties, except for the Situ Patenggang variety. Characteristics of observation of flowering age lines 23F-04-10-18-18 and 19I-06-09-23-03 had a higher harvest age than all the comparison varieties, while the 23A-56-20-07-20 line had a higher flowering age than all the comparison varieties, except for the Rindang variety.

**Table 2.** LSI results of 5 Rice Genotype Test and Comparative Varieties

| Genotype | Plant height (cm) | Flag leaf length (cm) | Flowering age (day) | Panicle length (cm) | Harvest age (day) | Number of grain/panicles (grain) | Number of pithy grains per plot (grain) | Weight per clump (g) | Weight 1000 grains per plot (g) | Pithy grain weight (g) | Grain weight per plot (g) | Empty Grain Weight per Plot (g) | Number of Live Plants (plant) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **19I-06-09-23-03** | 82.14 abcdef | 35.39b cdf | 73.58a bcde | 23.10 | 126.00 | 61.39 | 162.73ab | 7.10a | 37.59abc def | 90.01ab c | 147.22 | 77.43 bcef | 118.09 abde |
| **21B-57-21-21-23** | 98.31 abcdef | 25.06 | 81.58 | 20.94 | 116.00 acf | 89.77 f | 165.33ab | 7.23a | 30,51ae | 64.08b | 156.42a | 83.38 bce | 316.38 abcdef |
| **23A-56-20-07-20** | 88.31 abcdef | 20.36 | 74.08a bce | 20.94 | 114.00 abcdef | 62.92 | 159.57a | 5.25 | 26.18 | 56.94 | 120.68 | 32.66 abcdef | 109 abde |
| **23A-56-22-20-05** | 83.74 abcdef | 23.32 | 83.24 | 19,00 | 130.00 | 56.72 | 137.03a | 5.73 | 32.96abe f | 70,14ab | 134.45 | 32.33 abcdef | 252.33 abdef |
| **23F-04-10-18-18** | 95.98 abcdef | 33.19b cf | 68,58a bcde | 23.34bf | 116.00 ac f | 75.53 | 253,10ab cf | 10,20a bf | 34.59abc def | 89,41ab c | 164.05a | 43.66 abcdef | 285.66 abdef |
| **Danau Gaung+ LSI(a)** | 131.24 | 36.16 | 76.24 | 27.34 | 117,00 | 112.12 | 118.33 | 7.01 | 28,28 | 66.58 | 147.52 | 50 | 32.66 |
| **Inpago 12 + LSIb)** | 104.71 | 26.99 | 77.78 | 23.27 | 116.00 | 118.37 | 161.10 | 7.41 | 32.67 | 62.58 | 182.98 | 89 | 32.33 |
| **Inpago 8 + LSI(c)** | 115.44 | 30.49 | 76.58 | 25,40 | 123.00 | 101.07 | 185.43 | 10.90 | 33.30 | 71.34 | 312.58 | 209.66 | 300.33 |
| **Rindang + LSI(d)** | 116.04 | 33.46 | 73.91 | 24.67 | 115.00 | 93.04 | 341.17 | 13.58 | 33.21 | 367.64 | 457,88 | 69.66 | 104 |
| **Situ Patenggang+ LSI(e)** | 116.38 | 37.49 | 78.24 | 24.07 | 114.00 | 111.35 | 396.10 | 11.64 | 26.92 | 236.88 | 361.05 | 93.33 | 93 |
| **+ LSI ( f )** | 103.23 | 30,19 | 76.38 | 23.21 | 118.70 | 88.23 | 207.99 | 8.60 | 31.62 | 117.56 | 218.48 | 78.11 | 164.38 |
| **LSI** | 12.47 | 4.62 | 1.57 | 1.90 | 0.0000 03 | 17.50 | 47.66 | 2.14 | 3.35 | 30.81 | 62.01 | 43.09 | 22.38 |

Information:
1. $\bar{xg}$ = Genotype mean of offspring lines
2. The letter behind the number indicates that the test line is better than (a) Danau Gaung, (b) Inpago 12, (c) Inpago 8, (d) Rindang, (e) Situ Patenggang, and (f) the average genotype of the line
3. The letters in brackets that follow the test line code are the parent of the cross.
4. The test line was better than the comparison on the characters of harvest age, number of productive tillers, panicle length, production per empty pith plot, number of pithy grains, and 1000 grain weight if the test line check value + lsi, while on the character of plant height, age harvest, and if test line check value – lsi. ($\alpha = 0.05$)

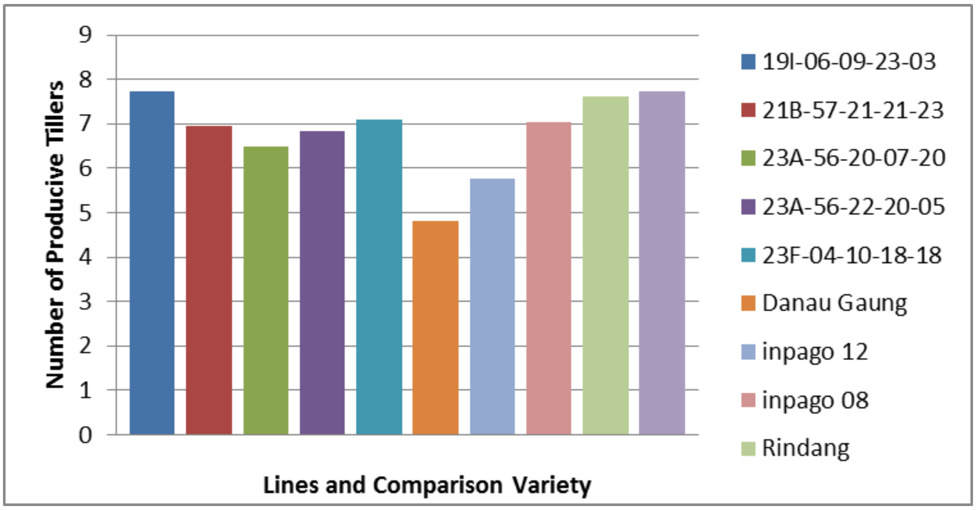


**Figure 2** Results of Analysis of the Number of Productive Tillers (a) 23A-56-20-07-20 , (b) 21B-57-21-21-23, (c) 23F-04-10-18-18, (d) 19I-06-09-23-03, (e) 23A-56-22-20-05, and comparison varieties (f) Danau Gaung, (g) Inpago 12, (h) Situ Patenggang, (i) Inpago 8, (j) Rindang

The qualitative character of the F7 line of upland rice observed from the crosses observed consisted of the lodging index and the color of the husk rice. The felling index value consisting of 5 fall-resistant rice lines and 5 comparison varieties can be seen in Table 3. All F7 rice lines from crosses had resistance to fall with a lodging index of 0% and all comparison varieties also had a lodging indexvalue of 0%. The qualitative character of the husk color of the F7 line and the comparison variety had the same color, except that the 23A-56-22-20-05 line had the red rice husk color. The color of the rice husk can be seen in Figure 3.

**Table 3.** Qualitative Characters of Rice F7 Rice Plants

| Line | Rice husk Color | Lodging Index (%) |
|---|---|---|
| 19I-06-09-23-03 | White | 0 |
| 21B-57-21-21-23 | White | 0 |
| 23A-56-20-07-20 | White | 0 |
| 23A-56-22-20-05 | Red | 0 |
| 23F-04-10-18-18 | White | 0 |
| Danau Gaung | White | 0 |
| Inpago 12 | White | 0 |
| Inpago 8 | White | 0 |
| Rindang | White | 0 |
| Situ Patenggang | White | 0 |

Remarks: Plants do not fall (very resistant to fall), plants fall less than 20% (resistant to fall), plants fall 21-40% (somewhat resistant to fall), plants fall 41-60% (moderate), plants fall 61-80 % (somewhat sensitive), fallen plants above 80% (sensitive) (IRRI 2013).

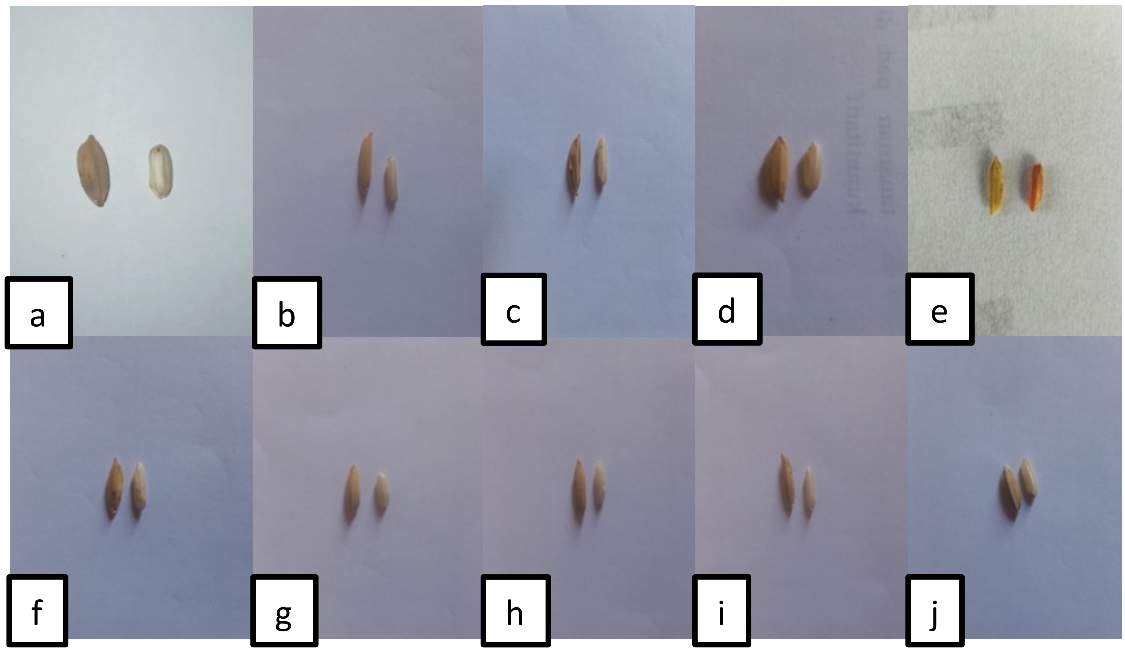


**Figure 3** Rice husk color of line (a) 23A-56-20-07-20 , (b) 21B-57-21-21-23, (c) 23F-04-10-18-18, (d) 19I-06-09-23-03, (e) 23A-56-22-20-05, and comparison varieties (f) Danau Gaung, (g) Inpago 12, (h) Situ Patenggang, (i) Inpago 8, (j) Rindang

**Table 4.** Recapitulation of Best Line Selection Results Based on LSI Test

| Line | Plant height (cm) | Flag leaf length (cm) | Flowe ring Age (DAP) | Panicle length (cm) | Harvest age (day) | Number of pithy grains (item) | Heavy per clump (g) | Weight 1000 grain (g) | Pithyg rain weight (g) | Grain plot weight (g) | Weight of Pitch Empty Grains (g) | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19I-06-09-23-03 | ✓ | ✓ | ✓ | × | × | ✓ | ✓ | ✓ | ✓ | × | ✓ | 8 |
| 21B-57-21-21-23 | ✓ | × | × | × | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 8 |
| 23A-56-20-07-20 | ✓ | × | × | × | ✓ | ✓ | × | × | ✓ | × | ✓ | 6 |
| 23A-56-22-20-05 | ✓ | × | × | × | × | ✓ | × | ✓ | ✓ | × | ✓ | 6 |
| 23F-04-10-18-18 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 11 |

Note: (✓) = indicates that the line is better than the comparison variety
( × ) = indicates that the line is less good than the comparison variety

Based on Table 4, the Recapitulation of the Best Line Selection Results Based on the LSI Test shows that 3 lines have the most total parameters, namely, line 23F-04-10-18-18 with the best total number of parameters, namely 10, Line 19I-06-09-23- 03 and 21B-57-21-21-23

The research on advanced yield testing aims to obtain selected lines and then carry out adaptation testing, then identify rice lines with high yields that have the potential as superior varieties. This is the basis for carrying out further yield tests on 5 F 7 lines of red rice that are resistant to lodging.

have a total number of parameters, namely 7. Based on this, it can be concluded that the 3 lines can be recommended as the next multi-site test line.

## 4. Discussion

The results of variance in Table 1 show that all parameters were significantly different from the genotype treatment. Parameters that show significantly different properties are then analyzed with the Least Significant Increase (LSI) further test. The tested genotype value which is greater than the comparison in the Least Significant Increase (LSI) follow-up test indicates that the test line has a good appearance and increases the chance of selection as a superior genotype [18].

The best lines based on the selection results in Table 4 are lines 23F-04-10-18-18, 21B-57-21-21-23, and 19I-06-09-23-03. This is based on the results of the plant height test parameter (cm), Flag leaf length (cm), Panicle length (cm), Flowering age (HST), Age of harvest (HST), Number of pithy grains per plot (grain), Clump weight (g), Weight of 1000 grains (g), Weight of pithy grains per plot (g), and Weight of grain per plot (g). Based on Table 1 that there are significant differences in the character of plant height in all test lines. The 23F -04-10-18-18 line had a higher height than all lines except for the 21B-57-21-21-23 line but had a lower height than the comparison variety. The character plant height <104 cm is classified as a short type of rice plant. Based on this statement, it can be said that all lines have short plant height [19]. Rice plants that have a low plant height character or <104 cm have an advantage against falling when blown by the wind [20] .

The character of the lodging index of all test lines was 0%, which means that there were no rice plants that fell or were very resistant to falling. This is by following per under IRRI [19] which states, the fallibility index is classified into (0%): very resistant to falling (plants do not fall), 1: resistant to fall (<20%), 3: moderately resistant to falling (21-40 %), 5: moderate (41-60%), 7: moderately sensitive (61-80%) and 9: sensitive (>80%). Plant height is one of the characteristics that affects the lodging index. The taller the rice plant, the more likely it is that a rice plant will fall. The laying character is influenced by the environment and the character of the plant itself, such as the number of productive tillers. The number of productive tillers, the 23F -04-10-18-18 line had quite a large number of tillers with an average of about 7.1 [21]. According to Zuliadi et al. [22], the number of productive tillers in rice was classified into three categories, namely: many (>20), medium (11-20), and few (<11) [22].

The 23F-04-10-18-18 line had the longest panicle character with a length of 23.34 cm. Based on the LSI data in Table 2. it was found that the panicle length of all test lines was included in the medium group. Panicle length can be influenced by productive tillers, the more productive tillers of rice plants, the shorter the panicle length and if the number of productive tillers is less, the panicle length will be longer [23].

The characters of the flag leaf length of the test lines with flag leaf length >30 cm were 23F-04-10-18-18 and 19I-06-09-23-03. Rice plants that have a low flag leaf area will cause the flag leaf's ability to act as a source after flowering to be also low. This will reduce the number of grains planted and the weight of grains per plot [24].

The weight of grain plots was influenced by the number of pithy grains, the weight of the clump, the weight of 1000 grains, and the weight of the grains of the plot. The highest number of pith grains per plot was line 23F-04-10-18-18. This is because the 23F-04-10-18-18 line has long panicles and flag leaves. The long flag leaf is a supplier of more photosynthate than the short flag leaf. The longer the flag leaf, the pithier grains are produced, and the heavier the grains are produced by the plant group. The number of grain and pithy grains is a component of rice yields, the higher the numberof grain, the higher the pithy rice obtained so the results obtained are also higher [25]. The weight of the 23F-04-10-18-18 cluster in Table 2 has a relatively high value compared to the other test lines, then the weight of the next heaviest clumps is 21B-57-21-21-23, and 19I-06-09-23 -03.

The character weight of 1000 grains of the test line on average was relatively the same as the yield of 1000 grains in the comparison variety. FAO classifies the weight of 1000 grains into light (<22 g), heavy (22-28 g), and very heavy (>28 g) [26]. This shows that all lines in Table 2 are grouped into very heavy except 23A-56-20-07-20 which is grouped into heavy only. The weight of the clump and the weight of 1000 grains later affected the weight of the grains in one plot. The line with the highest grain weight in the plot was 23F-04-10-18-18, then line 21B-57-21-21-23. In table 2 the minimum weight of empty grains is 23A-56-20-07-20, 23A-56-22-20-05 and 23F-04-10-18-18.

The flowering age of the test line had the fastest time of 68.58 days, namely 23F-04-10-18-18. The harvest age of the test line had the fastest flowering time of 114.00 days, namely 23A-56-20-07-20. Rice harvesting age was categorized into ultra-early (<90 DAS), very early (90-104 DAS), early (105-124 DAS), medium (125-150 DAS), and deep age (> 151 Days after Sowing). /HSS) [20]. Mustikarini et al. [10] stated that flowering time and harvest time are influenced by plant genes [27]. The rice husk color character of all test lines in Table 3 is white except for line 23A-56-22-20-05 which has a red epidermis color. The color of the rice husk is grouped into white rice called white rice, red and brown colors are called red rice, while purple varies with black rice [28]. Table 1 states that there is a significant difference in the number of plants that live in one plot of the bed. Line 21B-57-21-21-23 had more live plants than all comparison varieties, while lines 23A-56-22-20-05, 23A-56-20-07-20, 23F-04-10 -18-18, and 19I-06-09-23-03 had more number of plants than the comparison varieties except for the Inpago 8 variety. The variation characters of genotype caused by genetic factor brought by parental plant [29].

## 5. CONCLUSION

There are 3 (three) promising upland rice F7 lines, namely 23F-04-10-18-18, 19I-06-09-23-03, and 21B-57-21-21-23 which are better than the other F7 lines. The 23F-04-10-18-18 line is the best line because it has advantages in some traits, lodging resistance, and high yield. These traits were the number of pithy grains (grain), weight per clump (g), the weight of 1000 grains (g), and the weight of grains per plot (g).

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