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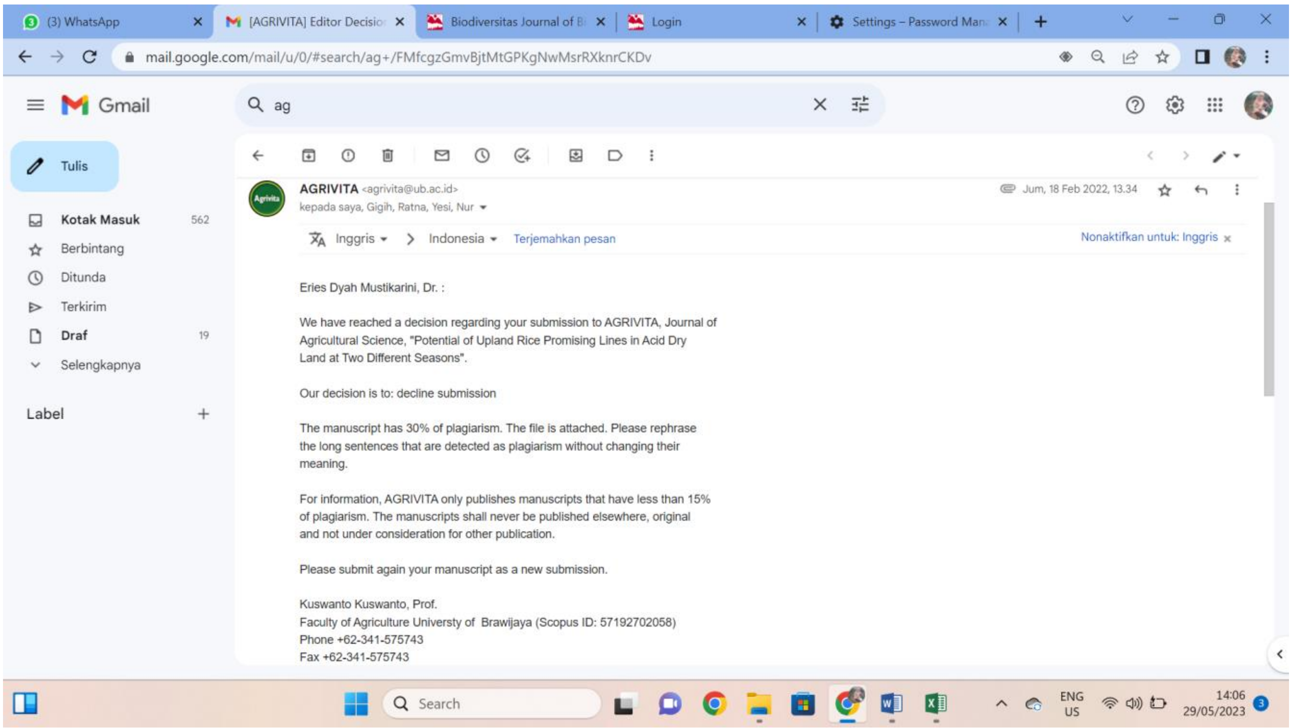
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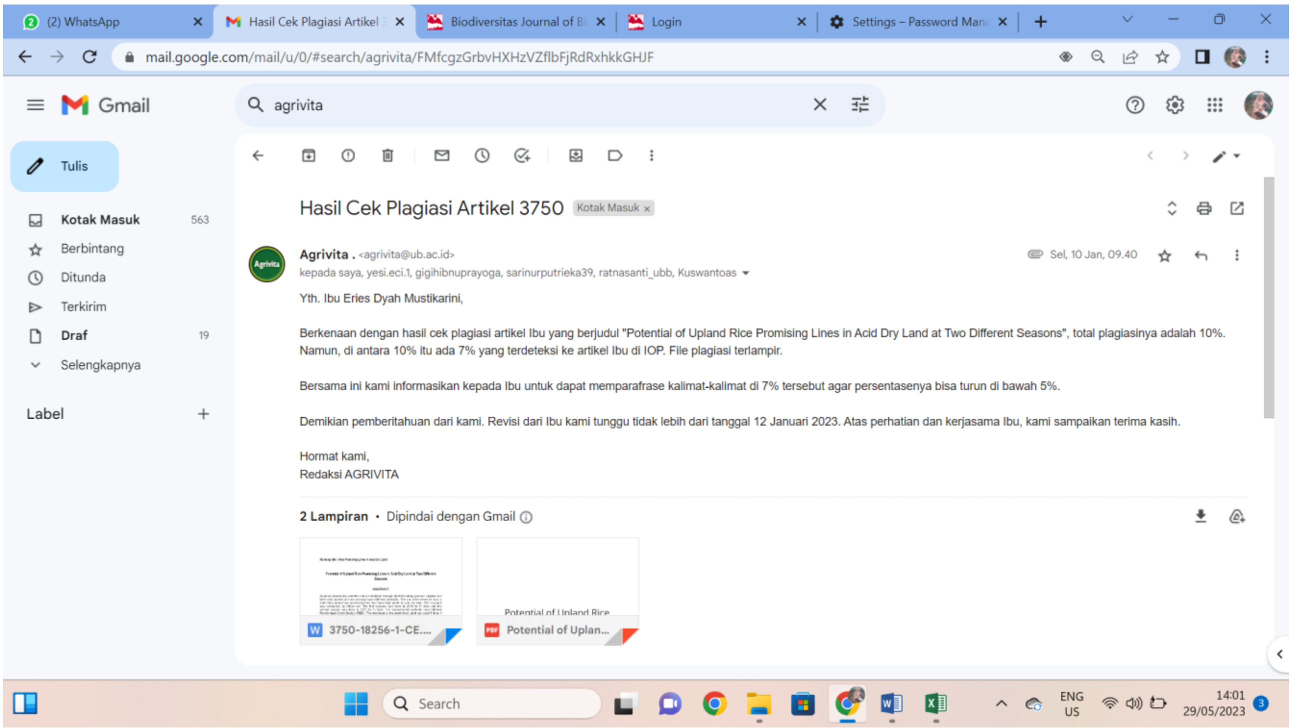
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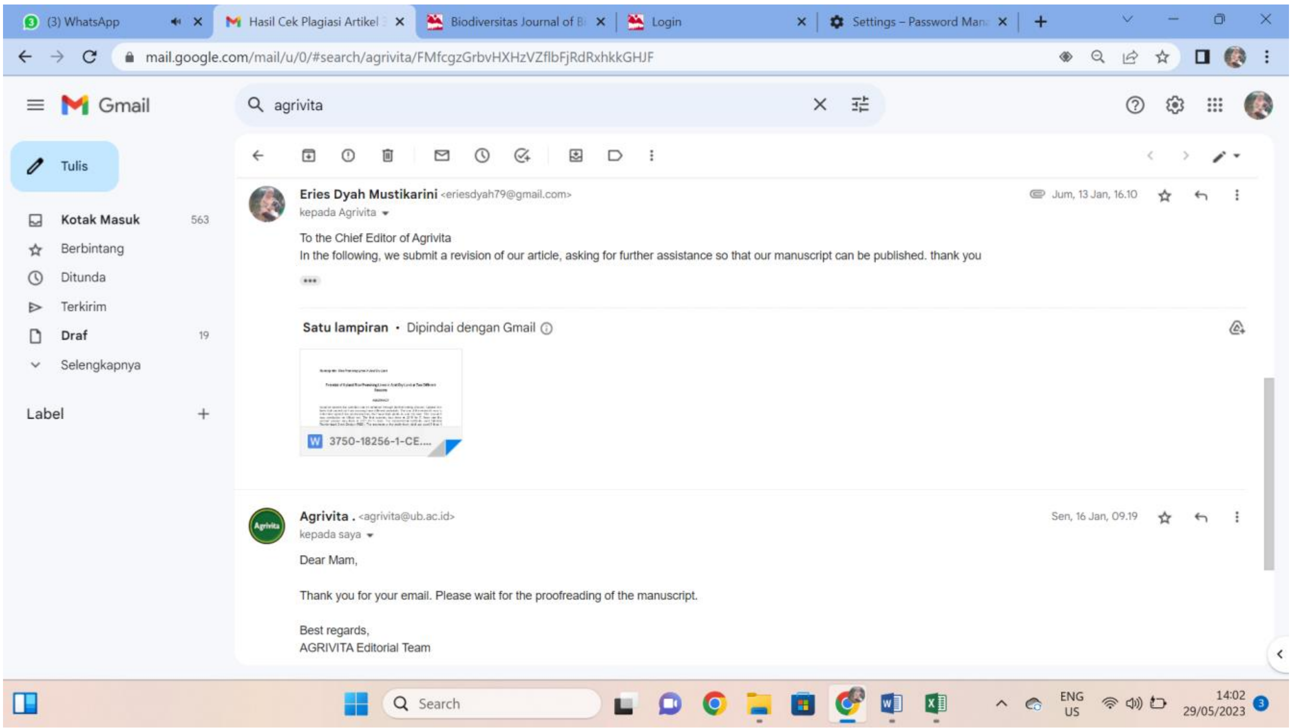

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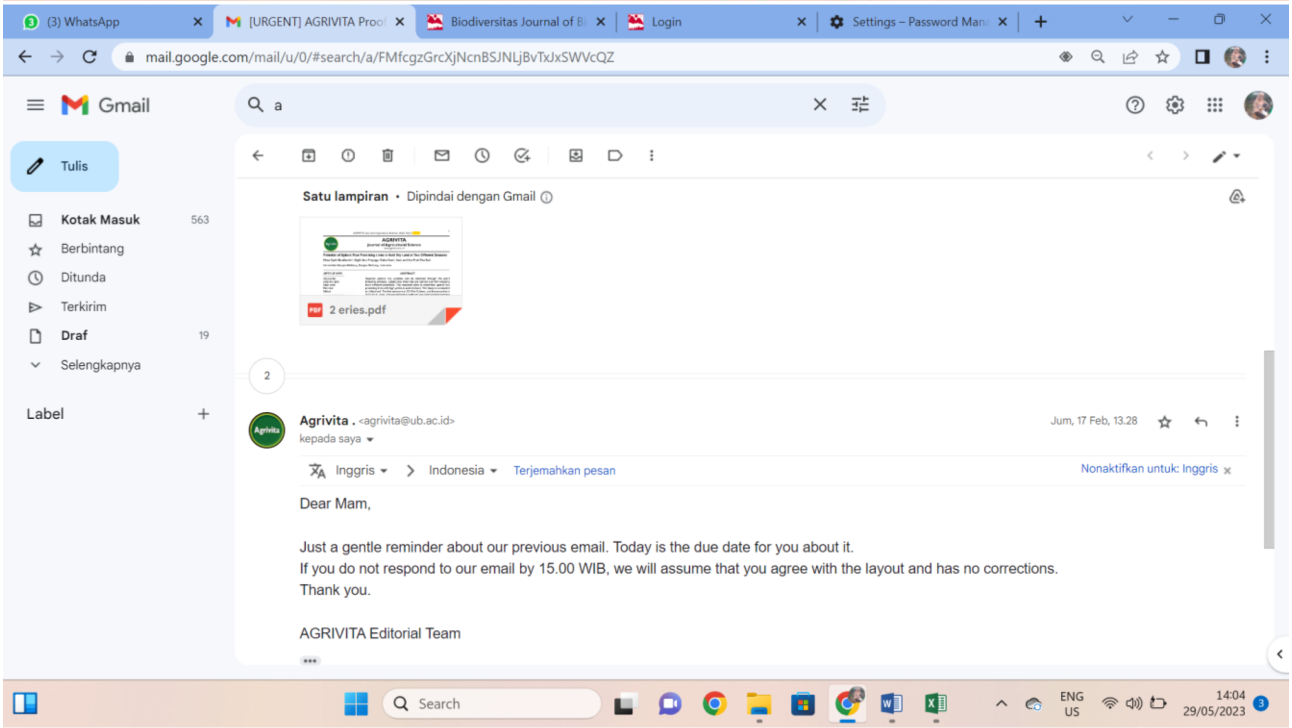

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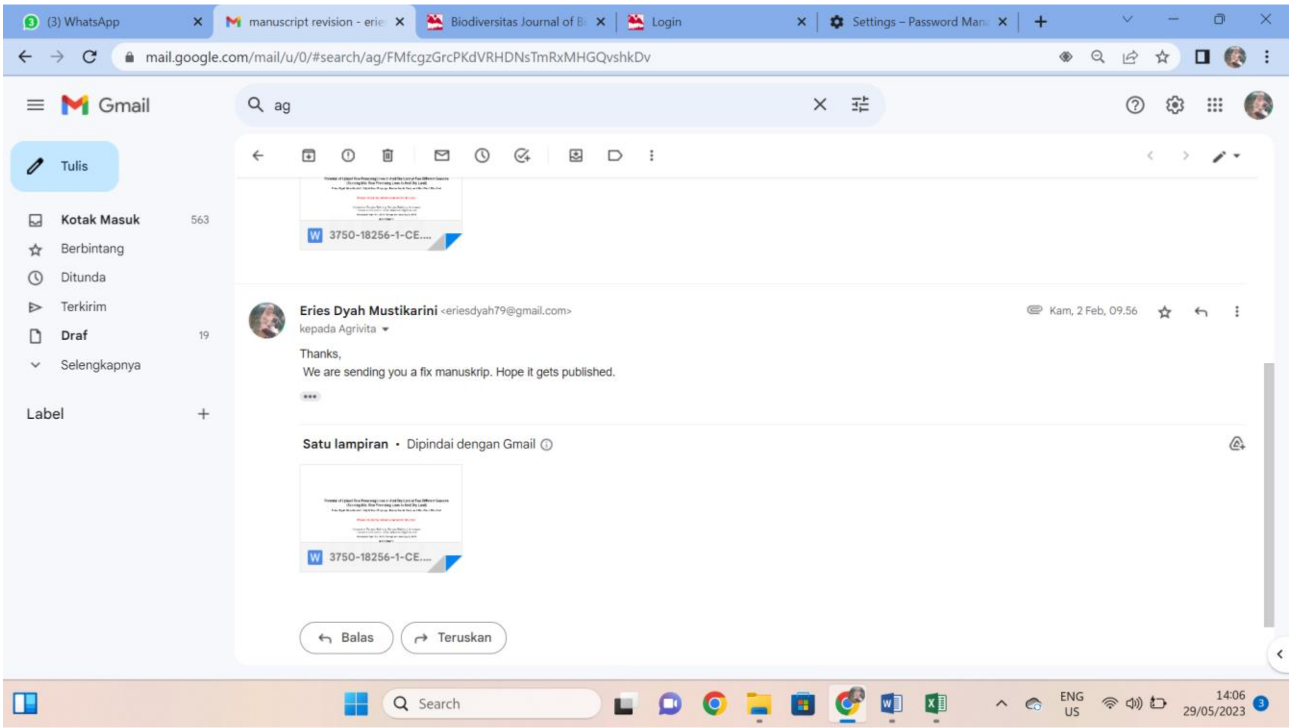

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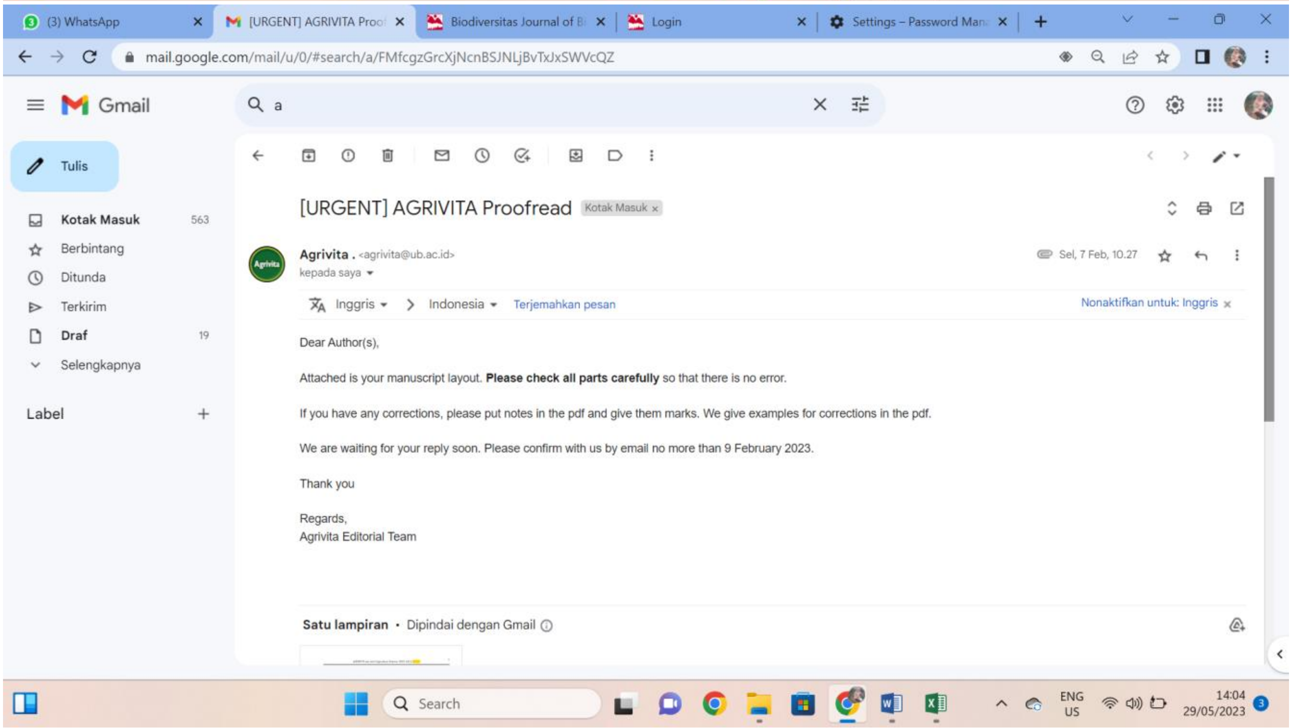

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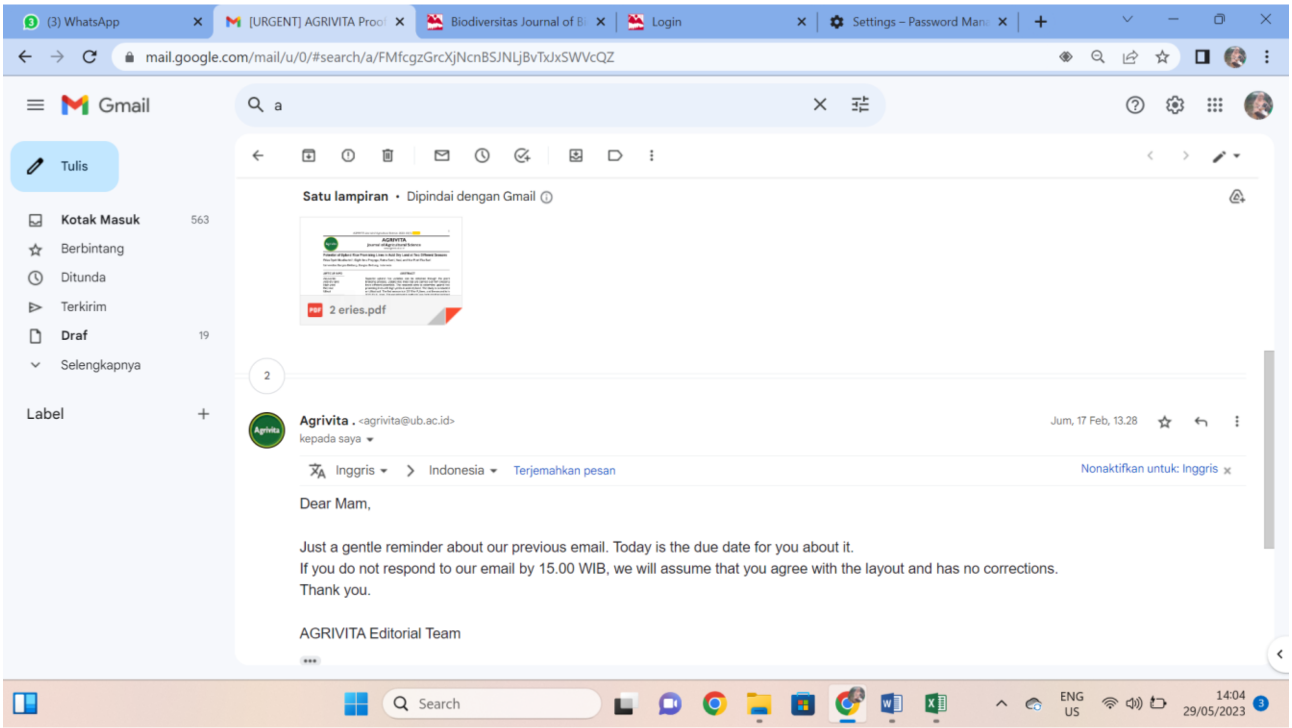

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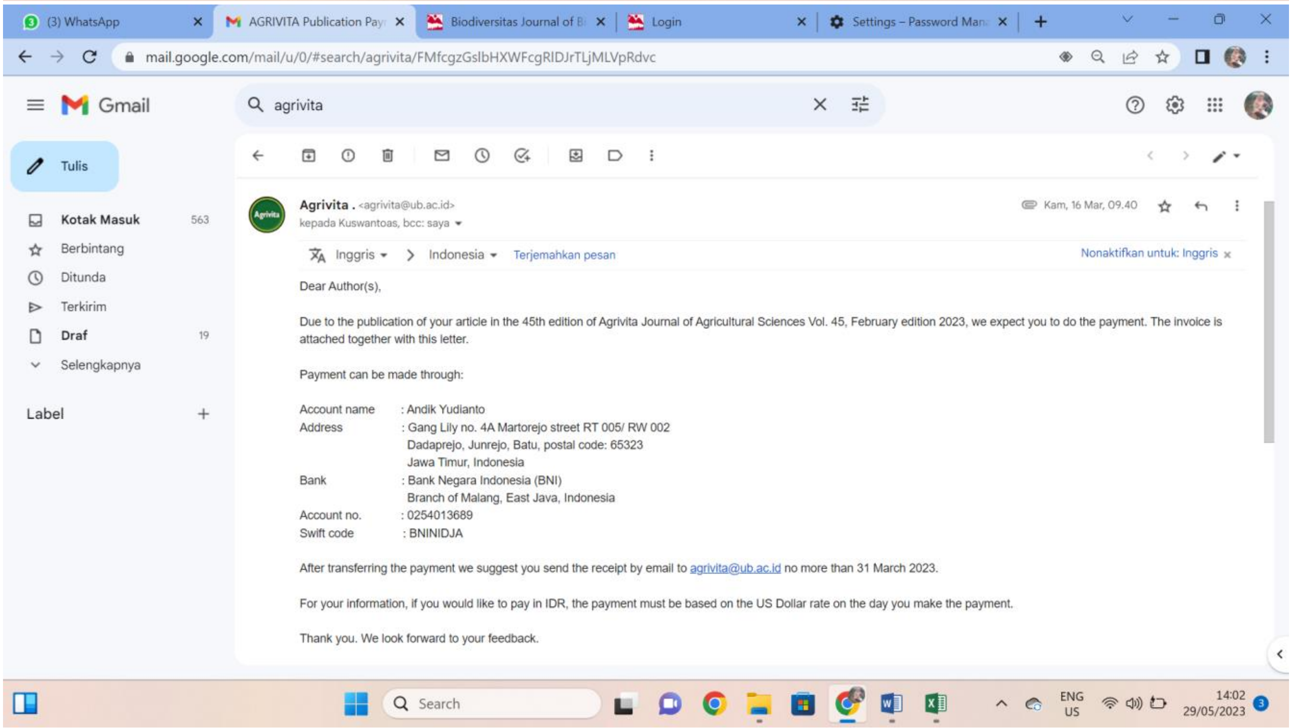

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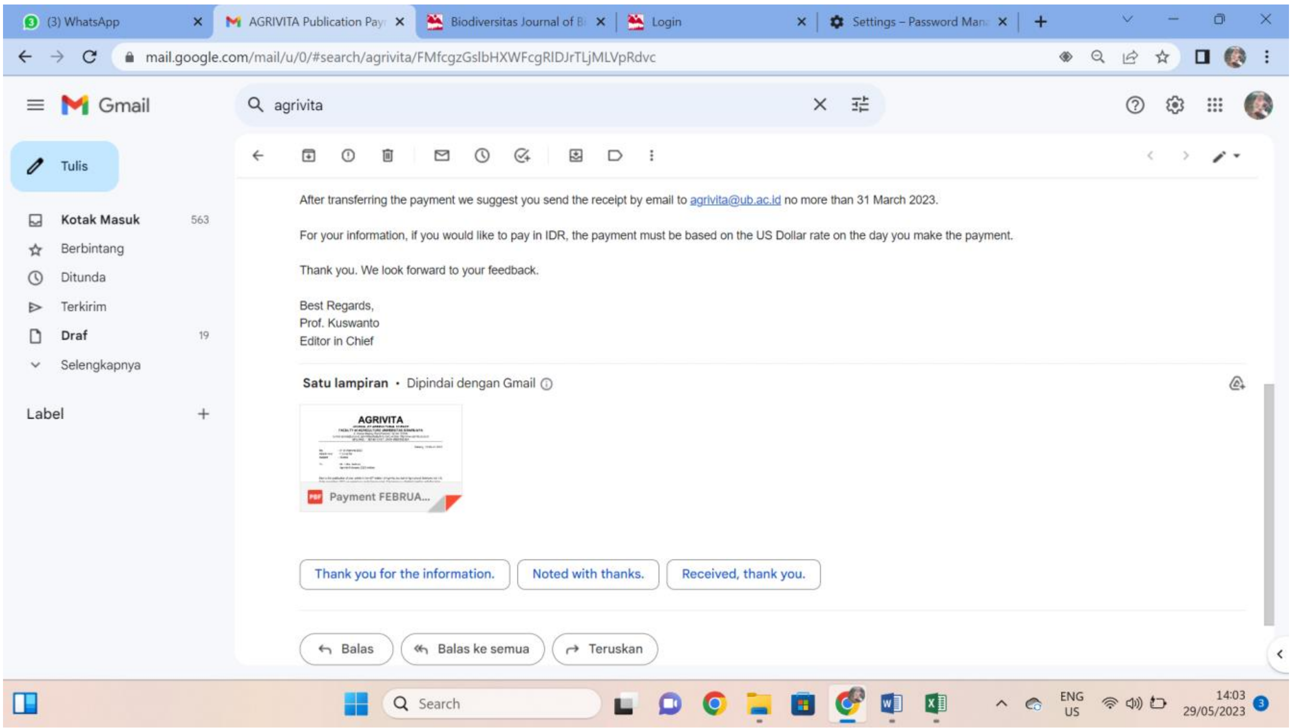
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Potential of Upland Rice Promising Lines in Acid Dry Land at Two Different Seasons

ABSTRACT (150-200 words)

Superior upland rice varieties can be obtained through plant breeding process. The upland rice promising lines have been obtained from crosses between landrace upland rice from Bangka with national varieties to develop upland rice with lodging resistance and had high yields in acid dry land. Upland rice lines that carried out from crossing have different potentials. The aim of the research was to determine upland rice promising lines that have high yields in acid dry land. The research was conducted on Ultisol soil in Bangka Belitung Province, Indonesia, in December 2019 - May 2021. The research consisted of two activities, preliminary yield tests for F_6 lines and advanced yield tests for F_7 lines. The experimental methods used Randomized Block Design (RBD). The treatment at the preliminary yield test used 10 F_6 lines, 6 varieties and 1 landrace as comparison plant. The advanced yield test used 5 F_7 lines (selected from F_6 lines) and 5 varieties as comparison plant. Analysis data used ANOVA and LSI test. The result showed that the F_6 lines that have higher yield than the comparison plant are lines of 23A-56-22-20-05 (4.75 tons/ha) and 23A-56-20-07-20 (3.15 tons/ha). The yield of F_7 lines ranged from 4.58-6.43 tons/ha. The F_7 lines 23A-56-22-20-05 and 23F-04-10-18-18 shows the higher yield than comparison plant. Based on these results, lines 23A-56-22-20-05 (brown rice) and 23F-04-10-18-18 (white rice) were recommended as candidates for high-yielding adaptive upland rice varieties in acid dry land.

Keywords: Acid dry land; Advanced yield test; Preliminary yield test;Upland Rice; Yield.

INTRODUCTION

Rice (*Oryza sativa* L.) is a daily staple food crop consumed by approximately 90% of the total population in Indonesia (Donggulo, Lapanjang, & Made, 2017). Rice can be classified on the color of the rice. The color of rice is categorized into three groups, namely white rice, brown rice and black rice (Abdullah, 2017). The color of rice is due to the content of anthocyanin pigments. Anthocyanins are phenolic compounds that belong to the flavonoid group and function as antioxidants(Yurnawati, Aryana, & Sutresna, 2018). Anthocyanins are located in certain layers of the rice grain, which could be separated into anthocyanin-rich fractions for use as functional colorants or functional food ingredients (Kim et al., 2013). Pramai & Jiamyangyuen (2016), the pigmented Thai rice varieties including red and black color and non-pigmented rice (white) collected from different growth sites in the north of Thailand and were determined for color and antioxidant properties. Maulani, Sumardi, & Pancoro, (2019), anthocyanins are a phenolic compound that belongs to the flavonoid group which plays an important role, both for the plant itself and human health, namely as an antioxidant. Gujral, Sharma, Kumar, & Singh, (2012), the total phenolic content in the brown rice from the three cultivars ranged from 0.803–0.885 mg ferulic acid equivalent/g flour. White rice per 100 g can contain nutrients in the form of energy 357 cal, protein 8.4 g, fat 1.7 g, carbohydrates 77.1 g, calcium 147 mg, phosphorus 81 mg and thiamine 0.2 mg (Handajani et al., 2020).

Most soil types in Bangka Belitung Province are classified as ultisol soil with acid dry characteristic. Ultisol soil types have low fertility, such as acid soil pH (4.54), C-organic, available P, Mg-dd, Ca-dd, low CEC and KB, total N, low K-dd and Na-dd, while the C/N ratio is moderate (Syukri, Nelvia, & Adiwirman, 2019). Developing of rice plant that adaptive to acid dry land is important. Genotypes that are not able to adapt to dry acid soil will inhibit vegetative growth and yield production, due to drought stress (Tirtana et al., 2021). Rice varieties that are known able to adapt to acid dry land are Inpago 8 (Nazirah, Purba, Hanum, & Rauf, 2016).

Superior genotype can be obtained through the hybridization process. Hybridization of landrace Bangka rice with national varieties has been done to get a lodging resistance lines with high yielding and adaptive to acid dry land (Mustikarini et al., 2019). Selection on F_4 generation were obtained 56 high yielding lodging resistance lines (Mustikarini, Prayoga, & Aprilian, 2020). In further research, the F_6 lines that can be used as candidates for new superior varieties are lines 23A-56-20-07-20 and 23A56-22-20-05 that have higher production than parental and check varieties (Mustikarini et al., 2021). The next stage that must be carried out is preliminary and advance yield test.

The yield tests are needed to determine the potential yield of plants (Syukur et al., 2012). The yield test is divided into two stages, namely preliminary and advanced yield tests. Preliminary yield tests were carried out on the F_6 and F_7 generations (Syukur et al. 2018), and the selected lines will proceed to the advanced yield test in the next season. According to Fatimaturrohmah et al. (2016), the results of the yield test are used as a reference for the multilocation test. Based on the description, the aim of the research was to determine upland rice promising lines that have high yields in acid dry land.

MATERIALS AND METHODS

The research was conducted in two experimental seasons. The first season from December 2019 to May 2020. The second season from December 2020 to May 2021. The research was carried out on ultisol land of experimental and research station, Universitas Bangka Belitung, Bangka Belitung Islands Province.

The research used the experimental methods Randomized Block Design (RBD). The treatment at the preliminary yield test stage used 10 F_6 lines which were the result of a cross between PBM UBB-1 X Balok, PBM UBB-1 X Banyuasin, PBM UBB-1 X Inpago 8, Balok X Inpago 8, and Balok X Banyuasin. The treatment used 5 F_7 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 check varieties (Danau Gaung, Inpago 8, Inpago 12, Rindang and Situ Patenggang). Lines 23A-56-22-20-05 is the only remaining lines of red rice, while the other lines are white rice. Plot size was 4 x 5 m with 320 plants for each plot.

The characters observed in the F_7 generation lines are plant height (cm), flag leaf length (cm), number of productive tillers, flowering age (DAP), panicle length (cm), harvest age (DAP), number of grains filled, yield per plot (kg), number of grains per panicle, weight of 1000 seeds (g), epidermis color rice, and organoleptic test. The data were analyzed using the Fisher test (ANOVA) at α 5% and Least Significant Increase (LSI) test (Ruchjaniningsih & Thamrin, 2016).

$$LSI = _{(0,05;db)} \sqrt{\frac{2MSE}{r}}$$

notes: : $t_{(0,05;db)}$ = t table; α = 0,05
MSE = Mean Square Error
r = replication

RESULTS AND DISCUSSION

Preliminary yield test was carried out to determine the potential of superior lines (Michel et al., 2017). Preliminary yield test was carried out to determine the potential of 10 lines F6. 10 lines have the properties of lodging resistance (Mustikarini et al. 2021).

The results of each F_6 line showed different characters to the comparison varieties. The difference in plant growth characters is caused by differences in the genetic characteristics of the plant itself (Syafi'ie & Damanhuri, 2018). Afifah et al., (2020) stated, if the value of the test genotype is greater than the comparison in the *Least Significant Increase* (LSI) follow-up test, it shows that the test line has a good appearance and increases the chance of selection as a superior genotype. All the lines at this stage had shorter plant heights than all the comparison varieties, except for the Banyuasin variety. The F_6 lines which had the shortest plant height was in line 23A-56-13-25-13 with a plant height of 73.10 cm (Table 1). The character of plant height <105 cm is classified as a short plant. The F6 and F7 lineages showed that they were classified as plants with short plant heights. The short plant characters came from the elders of Banyuasin and Inpago 8. Mustikarini *et al*. Mustikarini, Prayoga, & Aprilian (2020), stated that the diversity of plant heights in the test line had the influence of genes inherited from parents, namely the *Sd1-Sd7* gene. Rice plants with short stem phenotypes are not easy to fall if the wind blows, especially when the rice plants enter the fruit filling phase (Lestari, Kartahadimaja, & Hakim, 2017). Rice plants with shorter plant heights, so that the resulting photosynthesis results are allocated more for seed formation (Huang et al., 2018).

There were 2 lines which had longer flag leaf length than the Banyuasin variety, namely 19I-06-30-17-11 and 19I-06-09-23-03 (Table 1). Flag leaf length has a major effect on rice production (Rahmah & Aswidinnoor, 2014). The number of productive tillers in rice plants affects the number of panicles that will be produced.

Lestari, Kartahadimaja, & Hakim, (2017) stated, rice harvesting age was categorized into deep (>151 Days After Seedling/HSS), medium (125-150 DAS), early (105-124 DAS), very early (90-104 DAS) and super early (<90 HSS). Early harvest age is thought to be the result of offspring from Inpago 8 and Belok. Mustikarini et al., (2021) stated that flowering and harvesting age were controlled by the *Hd* gene. Weng et al., (2014), we show that the flowering time gene *Ghd7* also regulates plant architecture and such regulation is dependent on both genetic background and environmental signaling. Endo-Higashi & Izawa, (2011) rice plants two key flowering time genes, *Hd1* and *Ehd1*, also control panicle development. The desired harvest age in the plant breeding process is the early harvest age. Nurazizah, Hairmansis, & Damanhuri, (2019) adds, short harvesting ages have low yield potential because plants do not have enough time to use sunlight and nutrients in the soil.

The test line with the longest panicle of 20.6 was 21B-57-21-21-25, while the shortest 15.5 cm was 23A-56-13-25-13. Panicle length affects the amount of grain that will be produced (Nurazizah, Hairmansis, & Damanhuri, (2019). The longer the panicle, the more grain will be produced.

The F7 rice lines whice show greater than the check rice varieties based on the LSI test will have the potential to be a superior genotype (Carsono et al., 2020). Genotypes that have higher character values than check varieties in the LSI test indicate lines that perform well and include superior genotypes (Afifah et al., 2020). The rice line that had the shortest plant height was 23A-56-22-20-05, which is 63.83 cm (Table 2). The plant height of 5 (five) line showed shorter than the check varieties. The plant height of F_7 lines that belonged to the moderate category was found in the strain 23A-56-20-07-20 (98.30 cm). The plant height is influenced by the genetic factors of a cultivar (Damanik et al., 2012). The growth of plants that are not uniformly influenced by genetic differences cause that each cultivar has special characteristics and properties (Suete, Samudin, & Hasanah, 2017).

The desired harvest age in the plant breeding process is the early harvest age. The fast harvest age is able to increase the rice harvest period, so that rice productivity can be increased (Supriyanti, Supriyanta, & Kristamtini, 2015). The very fast age of rice harvest also does not necessarily increase productivity. The character of the total grain amount is known based on the total number of grain in one plant clump including empty grain. Total grain number of test lines ranged from 873.5-2923.75 grain with the highest total grain number was 23A-56-20-07-20 (Table 1). The line with the highest number of total grain in the F_7 generation was line 21B-57-21-21-23 (Table 2). Syafi'ie & Damanhuri, (2018), stated that the number of seeds per clump can be influenced by the character of the number of tillers and panicle length, the higher the two characters, the higher the number of seeds per clump. Kartina, Wibowo, & Rumanti, (2017) stated, the amount of grain produced will affect production. A high amount of grain will be followed by a high crop production as well. The character of the weight of 1000 seeds of the test line seeds was generally heavier than all the parents in the range of 23.3-27.7 g, except for the 23A-56-22-20-05 (20.7 g) line. The magnitude of the weight of 1000 seeds is not necessarily accompanied by high production.

Supriyanti, Supriyanta, & Kristamtini, (2015) stated, that the color of rice is grouped into white rice, which is called white rice, red and brown colors are called red rice, while purple varies with black rice. Mardiah et al., (2017) stated, the colors that consumers like are bright colors, while dull colors are not liked by consumers. Diagram 1 shows the rice color of line 23A-56-22-20-05 which is preferred because it is red compared to other lines. The cause of the color difference is due to the enactment of Mendel's law I and Mendel's law II (Afandi, Lita, & Sri, 2014). A pair of genes belonging to each test line is a combination of two parental alleles combination. The dominant allele will be expressed, while the recessive allele that is not expressed will still be inherited in the gametes formed in the offspring. In accordance with the dominant trait, one of the parents will produce more white epidermis, while the recessive trait will produce less red epidermis. The red color in rice is controlled by the *Rc* gene sequence, black rice is controlled by the *OSB1* gene *sequence*, while white rice is controlled by the *DFR* gene (Lim & Ha, 2013).

Mustikarini et al., (2021) added, long panicles have a greater burden so that rice stalks become curved and prone to fall. This makes long panicles not necessarily able to increase production. Farmers prefer medium panicle length to long and short panicles (Perdani et al., 2020). Line 23A-56-22-20-05 with a production of 9.5 kg/plot (4.75 tons/ha) has the potential to be developed. Line 23A-56-20-07-20 had a yield close to the national productivity of 6.3 kg/plot (3.15 tons/ha). The F_7 line that showed the highest yield was 23A-56-22-20-05. Line of 23A-56-22-20-05 resulted has advantages on the plant height, productive tiller number, flowering age, harvest age, yield per plot, and weight of 1000 seeds. This line is a type of upland red rice. The 23A-56-22-20-05 line was able to produce 6.43 tons/ha of rice yield.The second highest yield was 23F-04-10- 18-18 line with the production approximately 6.40 tons/ha of rice yield.

CONCLUSIONS AND SUGGESTION

Two F_6 lines which have higher yield than the comparison plant are lines 23A-56-22-20-05 and 23A-56-20-07-20. The line 23A-56-22-20-05 (4.75 tons/ha) have higher yield than Banyuasin, Danau Gaung, Inpago 8 and PBM UBB-1, where line 23A-56-20-07-20 (3.15 tons/ha) higher than Banyuasin, Inpago 8 and PBM UBB-1. The yield of F_7 lines ranged from 9.17-12.87 kg/plot, or equivalent to 4.58-6.43 tons/ha. The F_7 lines 23A-56-22-20-05 and 23F-04-10-18-18 shows the higher yield than comparison plant, so lines 23A-56-22-20-05 (brown rice) and 23F-04-10-18-18 (white rice) were recommended as candidates for high-yielding adaptive upland rice varieties in acid dry land.

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REFERENCES

Abdullah, B. (2017). Peningkatan Kadar Antosianin Beras Merah dan Beras Hitam Melalui Biofortifikasi / Increasing Anthocyanin of Red and Black Rice through Biofortification. *Jurnal Penelitian dan Pengembangan Pertanian*, *36*(2), 91–98. https://doi.org/10.21082/jp3.v36n2.2017.p91-98

Afandi, S. W., Lita, S., & Sri, P. L. (2014). Penampilan Tujuh Genotip Padi (*Oryza Sativa* L.) Hibrida Japonica pada Dua Musim Tanam The Performance The Performance Of The Seven Japonica Hybrid Rice (*Oryza sativa* L) Genotypes In Two Seasons. *Jurnal Produksi Tanaman*, *2*(7), 583–591.

Afifah, Z., Carsono, N., Sari, S., & Anas, A. (2020). Uji Daya Hasil dan Seleksi Famili Padi Generasi F4 dan F6 Hasil Persilangan Sintanur x PTB 33 dan Pandanwangi x PTB 33 di Jatinangor. *AGROSAINSTEK: Jurnal Ilmu dan Teknologi Pertanian*, *4*(1), 28–34. https://doi.org/10.33019/agrosainstek.v4i1.96

Carsono, N., Fitria, N., Sari, S., & Ruswandi, D. (2020). Karakterisasi Mutu Fisik Bulir 30 Genotipe Padi Generasi F5 Hasil Seleksi dari Persilangan Sintanur X PTB33 dan Pandanwangi X PTB33. *Agrikultura*, *31*(3), 166–173. https://doi.org/10.24198/agrikultura.v31i3.29779

Damanik, R. I., Ismail, M. R., Shamsuddin, Z., Othman, S., Zain, A. M., & Maziah, M. (2012). Response of Antioxidant Systems in Oxygen Deprived Suspension Cultures of Rice (*Oryza sativa* L.). *Plant Growth Regulation*, *67*(1), 83–92. https://doi.org/10.1007/s10725-012-9668-4

Donggulo, C. V, Lapanjang, I. M., & Made, U. (2017). Pertumbuhan Dan Hasil Tanaman Padi (*Oryza sativa* L) Pada Berbagai Pola Jajar Legowo Dan Jarak Tanam Growth And Yield Of Rice (*Oryza sativa* L.) Under Different Jajar Legowo System And Planting Space. *J. Agroland*, *24*(1), 27–35.

Endo-Higashi, N., & Izawa, T. (2011). Flowering Time Genes Heading Date 1 and Early Heading Date 1 Together Control Panicle Development in Rice. *Plant and Cell Physiology*, *52*(6), 1083–1094. https://doi.org/10.1093/pcp/pcr059

Fatimaturrohmah, S., Rumanti, I. A., Soegianto, A., & Damanhuri, D. (2016). Hibrida di Dataran Medium Advance Yield Trials Some Genotype Of Rice Hybrid (*Oryza sativa* L.) at Medium Land. *Jurnal Produksi Tanaman*, *4*(2), 129–136.

Gujral, H. S., Sharma, P., Kumar, A., & Singh, B. (2012). Total Phenolic Content and Antioxidant Activity of Extruded Brown Rice. *International Journal of Food Properties*, *15*(2), 301–311. https://doi.org/10.1080/10942912.2010.483617

Handajani, S., Sulandari, L., Purwidiani, N., & Zamroh, beta seftiyany. (2020). Study of Rice Analog from Cassava–Soybean and Processed Product. *ICONHOMECS 2019*, *406* (Iconhomecs 2019), 287–297. https://doi.org/10.2991/assehr.k.200218.046

Huang, J., Li, J., Zhou, J., Wang, L., Yang, S., Hurst, L. D., Li, W. H., & Tian, D. (2018). Identifying a Large Number of High-Yield Genes in Rice by Pedigree Analysis, Whole-Genome Sequencing, and CRISPR-Cas9 Gene Knockout. *Proceedings of the National Academy of Sciences of the United States of America*, *115*(32), E7559–E7567. https://doi.org/10.1073/pnas.1806110115

Kartina, N., Wibowo, B. P., & Rumanti, I. A. (2017). Korelasi Hasil Gabah dan Komponen Hasil Padi Hibrida Correlation of Grain Yield and Yield Components of Hybrid Rice Varieties. *Jurnal Penelitian Pertanian Tanaman Pangan*, *1*(1), 11–20. https://www.neliti.com/id/publications/139097/korelasi-hasil-gabah-dan-komponen-hasil-padi-hibrida.

Kim, S.-K., Shin, J.-H., Kang, D.-K., Kim, S.-Y., & Park, S.-Y. (2013). Changes of Anthocyanidin Content and Brown Rice Yield in Three Pigmented Rice Varieties Among Different Transplanting and Harvesting Times. *Korean Journal of Crop Science*, *58*(1), 28–35. https://doi.org/10.7740/kjcs.2013.58.1.028

Lestari, A. T., Kartahadimaja, J., & Hakim, N. A. (2017). Uji Daya Hasil Empat Galur Padi Generasi Ke Empat di Lahan Politeknik Negeri Lampung. *Jurnal Penelitian Pertanian Terapan*, *17*(3), 165. https://doi.org/10.25181/jppt.v17i3.298

Lim, S. H., & Ha, S. H. (2013). Marker Development for The Identification of Rice Seed Color. *Plant Biotechnology Reports*, *7*(3), 391–398. https://doi.org/10.1007/s11816-013-0276-1

Mardiah, Z., Septianingrum, E., Handoko, dody d., & Kusbiantoro, B. (2017). No Titleimprovement of Red Rice Eating Quality Through One-Time Polishing Process and Evaluation on its Phenolic And Anthocyanin Content. *International Journal of Agriculture, Forestry and Plantation*, *Vol. 5*, 23–24.

Maulani, R. R., Sumardi, D., & Pancoro, A. (2019). Total Flavonoids and Anthocyanins Content of Pigmented Rice. *Drug Invention Today* |, *12*(2), 369–373.

Michel, S., Ametz, C., Gungor, H., Akgöl, B., Epure, D., Grausgruber, H., Löschenberger, F., & Buerstmayr, H. (2017). Genomic Assisted Selection for Enhancing Line Breeding: Merging Genomic and Phenotypic Selection in Winter Wheat Breeding Programs with Preliminary Yield Trials. *Theoretical and Applied Genetics*, *130*(2), 363–376. https://doi.org/10.1007/s00122-016-2818-8.

Mustikarini, E. D., Prayoga, G. I., Santi, R., & Hairul, H. (2021). Genetic Parameters of F6 Upland Rice with Lodging Resistance Derived from Landraces X National Varieties. *IOP Conference Series: Earth and Environmental Science*, *741*(1), 1–7. https://doi.org/10.1088/1755-1315/741/1/012010.

Mustikarini, E. D., Prayoga, G. I., Santi, R., Nurqirani, Z., & Saragi, H. (2019). Genetic Parameter Contributing to Lodging Resistance of F2 Population in Red Rice. *IOP Conference Series: Earth and Environmental Science*, *334*(1), 1–8. https://doi.org/10.1088/1755-1315/334/1/012066

Mustikarini, Eries Dyah, Prayoga, G. I., & Aprilian, B. (2020). Seleksi Galur Generasi F4 Padi Beras Merah Tahan Rebah. *AGROSAINSTEK: Jurnal Ilmu dan Teknologi Pertanian*, *4*(1), 1–9. https://doi.org/10.33019/agrosainstek.v4i1.105

Nazirah, L., Purba, E., Hanum, C., & Rauf, A. (2016). Characterization of Tolerant Upland Rice to Drought on Rooting and Physiology. *Journal of Agriculture and Life Sciences*, *3*(2), 43–49.

Nurazizah, A., Hairmansis, A., & Damanhuri. (2019). Uji Daya Hasil Dan Pendugaan Parameter Genetik Karakter Agronomi Genotipe Padi Gogo (*Oryza sativa* L.). *Jurnal Produksi Tanaman*, *7*(12), 2223–2229.

Perdani, A. Y., Mulyaningsih, E. S., Sulistyowati, Y., Suherman, S., Sanjaya, I., & Prastyo, M. (2020). Preferensi Petani terhadap 15 Galur Padi Gogo Ditabalong-Kalimantan Selatan. *Jurnal Agrotek Tropika*, *8*(1), 131. https://doi.org/10.23960/jat.v8i1.3691

Pramai, P., & Jiamyangyuen, S. (2016). Chemometric Classification of Pigmented Rice Varieties Based on Antioxidative Properties in Relation to Color. *Songklanakarin Journal of Science and Technology*, *38*(5), 463–472. https://doi.org/10.14456/sjst-psu.2016.62

Rahmah, R., & Aswidinnoor, H. (2014). Uji Daya Hasil Lanjutan 30 Galur Padi Tipe Baru Generasi F6 Hasil dari 7 Kombinasi Persilangan. *Bul. Agrohorti*, *1*(4), 1–8. https://hsgm.saglik.gov.tr/depo/birimler/saglikli-beslenme-hareketli-hayat-db/Yayinlar/kitaplar/diger-kitaplar/TBSA-Beslenme-Yayini.pdf

Ruchjaniningsih, N., & Thamrin, M. (2016). Penampilan Genotipe Jagung Berumur Genjah pada Pemupukan N Dosis Tinggi dan Rendah di Lahan Sawah setelah Padi di Sulawesi Selatan. *Buletin Plasma Nutfah*, *19*(2), 81. https://doi.org/10.21082/blpn.v19n2.2013.p81-88

Suete, F., Samudin, S., & Hasanah, U. (2017). Growth Response Upland Rice (*Oryza sativa*) Cultivars Local on Various Levels Moisture Land. *e-j. Agrotekbis*, *5*(2), 173–182.

Supriyanti, A., Supriyanta, S., & Kristamtini, K. (2015). Karakterisasi Dua Puluh Padi (*Oryza Sativa* L.) Lokal di Daerah Istimewa Yogyakarta. *Vegetalika*, *4*(3), 29–41.

Syafi'ie, M. M., & Damanhuri. (2018). Uji Daya Hasil Pendahuluan Mutan (M7) Padi Merah (*Oryza Nivara* L.) pada Musim Penghujan. *Jurnal Produksi Tanaman*, *6*(6), 1028–1033.

Syukri, A., Nelvia, N., & Adiwirman, A. (2019). Aplikasi Kompos Tandan Kosong Kelapa Sawit dan Pupuk NPKmg Terhadap Sifat Kimia Tanah Ultisol dan Kadar Hara Daun Kelapa Sawit (*Elaeis guineensis* Jacq). *Jurnal Solum*, *16*(2), 49–59. https://doi.org/10.25077/jsolum.16.2.49-59.2019

Tirtana, A., Purwoko, B. S., Dewi, I. S., & Trikoesoemaningtyas. (2021). Selection of Upland Rice Lines in Advanced Yield Trials and Response to Abiotic Stress. *Biodiversitas*, *22*(10), 4694–4703. https://doi.org/10.13057/biodiv/d221063

Weng, X., Wang, L., Wang, J., Hu, Y., Du, H., Xu, C., Xing, Y., Li, X., Xiao, J., & Zhang, Q. (2014). Grain Number, Plant Height, and Heading Date7 is a Central Regulator of Growth, Development, and Stress Response. *Plant Physiology*, *164*(2), 735–747. https://doi.org/10.1104/pp.113.231308

Yurnawati, Y., Aryana, I. G. ., & Sutresna, I. W. (2018). Uji Daya Hasil Galur Generasi F3 Padi Beras Merah (*Oryza sativa* L.). *Jurnal Sains Teknologi & Lingkungan*, *4*(1), 73–82. https://doi.org/10.29303/jstl.v4i1.74

Table 1. Results LSI Test of 17 Rice Genotypes of Preliminary Yield Test Results in Generation F_6.

Genotypes	Plant height (cm)	Flag leaf length (cm)	Productive tiller number (tiller)	Flowering age (DAP)	Panicle length (cm)	Harvest age (DAP)	Yield per plot (kg)	Total grain (seeds)	Weight of 1000 seeds (gr)
19I-06-30-17-11(fxd)	86.25 acefg	30.39 b	11.75	79.7 bf	20.52 b	111.00 bf	3.82 f	878.00	25.32 abdef
23A-56-13-25-13(axb)	73.10 acdefg	22.32	18.10 abcfg	63.4 abcdefgh	15.51	100.50 abcefh	3.48	1118.35 bf	25.39 abdef
19I-06-09-23-03(fxd)	82.15 acdefg	32.04 bdh	15.90 acf	71.0 abcdefgh	19.30 b	104.00 bfh	4.93 bf	1732.05 bcdf	25.50 abdef
21B-57-21-21-23(dxa)	96.60 acefg	29.69 b	13.30 c	77.9 abcfh	20.16 b	110.00 bf	5.55 bdf	1104.50 bf	26.38 abdef
23F-04-10-18-18(axd)	88.20 acefg	26.28	16.30 acf	73.6 abcdefgh	18.79 b	114.00 bf	5.59 bdf	873.50	27.66 abdef
21B-57-21-21-25(dxa)	86.80 acefg	25.49	12.25 c	73.3 abcdefgh	20.59 b	110.50 bf	2.84	1045.80 bf	24.11 abdef
23A-56-30-25-12(axb)	88.85 acefg	26.80	13.65 c	75.5 abdefh	19.92 b	110.00 bf	4.15 bf	1082.90 bf	26.03 abdef
23A-56-20-07-20(axb)	92.30 acefg	27.33	35.50 abcdefgh	71.8 abcdefgh	19.00 b	102.50 abfh	6.26 bdf	2923.75 abcdefgh	23.28 bdef
23A-56-24-22-13(axb)	75.70 acdefg	19.56	17.80 abcf	75.8 abdefh	15.57	103.50 bfh	5.11 bf	1073.10 bf	24.77 abdef
23A-56-22-20-05(axb)	76.30 acdefg	24.39	47.70 abcdefgh	80.7 bf	16.48	112.50 bf	9.53 bcdfh	2546.15 abcdefgh	20.73 bf
Balok+LSI (a)	141.21	46.28	15.45	78.6	25.80	103.15	9.91	1885.28	24.10
Banyuasin+LSI (b)	56.76	29.23	17.30	84.5	16.80	115.15	3.83	932.38	20.23
Danau Gaung+LSI (c)	114.86	42.41	11.90	75.2	27.43	101.15	6.90	1274.58	29.76
Inpago 8+LSI (d)	82.56	30.48	20.15	77.1	22.39	98.65	5.51	1421.73	22.44
Inpago 12+LSI (e)	103.66	37.77	18.55	77.8	23.57	102.15	13.23	2417.53	23.13
PBM UBB-1+LSI (f)	151.41	40.64	14.60	86.9	23.61	122.15	3.63	968.83	18.79
Rindang 1+LSI (g)	103.56	37.21	18.00	74.6	25.83	97.65	11.53	2116.83	28.48
$\bar{x}g$+LSI (h)	**72.49**	**30.66**	**26.33**	**78.1**	**20.61**	**104.50**	**8.06**	**1918.39**	**27.89**
LSI	**12.14**	**4.23**	**6.10**	**3.9**	**2.03**	**3.35**	**2.93**	**480.58**	**2.98**

Description: 1. $\bar{x}g$ = Average offspring genotype lines.

2. The letter behind the number indicates that the test line is better than (a) Balok, (b) Banyuasin, (c) Danau Gaung, (d) Inpago 8, (e) Inpago 12, (f) PBM UBB-1, (g) Rindang 1, and (h) the average genotype of the lineage.

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 flag leaf length, number of productive tillers, panicle length, production per plot, total grain count, and 1000 grain weight if the test line check value + LSI, while on the character of plant height, harvest age, and loss if the test line check value – LSI (α = 0.05).

Table 2. **Results LSI Test of 10 Rice Genotypes of Advance Yield Test Results in Generation F_6.**

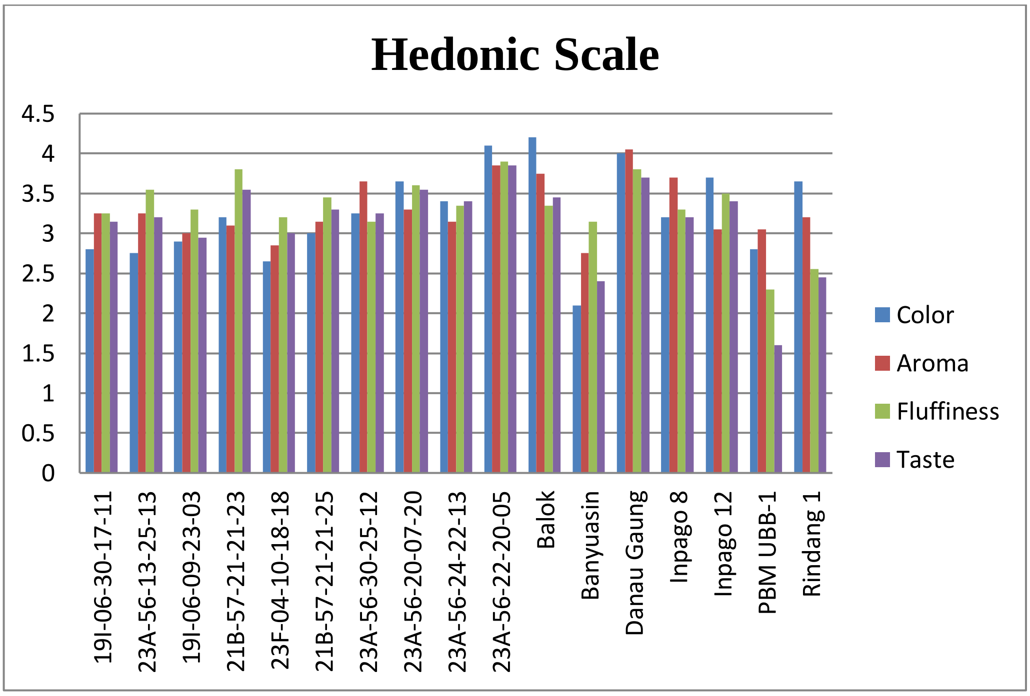
Genotypes	Plant height (cm)	Flag leaf length (cm)	Productive tiller number (tiller)	Flowering age (DAP)	Panicle length (cm)	Harvest age (DAP)	Yield per plot (kg)	Total grain (seeds)	Weight of 1000 seeds (gr)
19I-06-09-23-03 (dxc)	77.12 abcdef	35.02 bcf	40.48 abcde	75,60 acde	23,44	124,13 ac	9,17	1579.75 cde	29,53 bde
21B-57-21-21-23 (cxa)	90.87 abcde	29.05 c	32.92 abde	73,54 acde	23,88	113,67 abcdf	12,01 a	1659.20 cde	29,21 bde
23A-56-20-07-20 (axb)	98.30 abcde	25.95	40.62 abcde	71,60 abcdef	25,24	112,00 abcdef	12,51 a	1608.55 cde	27,89 de
23A-56-22-20-05 (axb)	63.83 abcdef	25.19	43.65 abcde	73,57 acde	22,07	114,07 abcdf	12,87 ad	1500.52 cde	28,23 de
23F-04-10-18-18 (axc)	77.96 abcdef	29.26 c	39.75 abcde	72,04 abcdef	24,77	115,00 acdf	12,80 a	1494.98 cd	28,56 de
Danau Gaung+LSI (a)	141.92	42.11	30.45	77,51	33,08	126,61	9,73	2119.30	34,34
Inpago 12+LSI (b)	119.10	32.05	30.28	73,25	26,88	116,61	13,24	2048.35	28,99
Inpago 8+LSI (c)	116.00	28.29	35.45	78,91	26,50	125,98	13,79	1278.31	32,38
Rindang+LSI (d)	131.13	38.16	29.92	76,25	28,47	119,94	12,83	1341.66	26,85
Situ Patenggang+LSI (e)	123.33	41.83	24.28	78,41	27,80	113,61	17,17	1499.17	27,11
$\bar{g}$ + LSI (f)	**82.01**	**33.28**	**49.80**	**73,27**	**26,60**	**115,77**	**14,12**	**2099.57**	**35,02**
LSI	**9.99**	**4.39**	**10.31**	**1,61**	**2,72**	**3,61**	**2,25**	**530.97**	**6,33**

Description:

1. $\bar{x}g$ = Average offspring genotype lines.
2. 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 Rindang, and (e) better than Situ Patenggang.
3. The letters in brackets that follow the test line code are the parent of the cross.
4. The letter in parentheses is a symbol to indicate the check rice varieties; g = Average value of F_7 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.

Table 3. Results of Observation of Plant Qualitative Characters in Rice Plants Generation F_6.

Genotype	Rice Aris Skin Color
19I-06-30-17-11	Yellowish White
23A-56-13-25-13	Yellowish White
19I-06-09-23-03	Yellowish White
21B-57-21-21-23	Yellowish White
23F-04-10-18-18	Yellowish White
21B-57-21-21-25	Yellowish White
23A-56-30-25-12	Yellowish White
23A-56-20-07-20	Yellowish White
23A-56-24-22-13	Yellowish White
23A-56-22-20-05	Yellowish White
Balok	Yellowish White
Banyuasin	Yellowish White
Danau Gaung	Yellowish White
Inpago 8	Yellowish White
Inpago 12	Yellowish White
PBM UBB-1	Yellowish White
Rindang 1	Yellowish White



Histogram 1. Panelist's Level of Preference for Color, Aroma, Fluffiness and Taste of Rice

Potential of Upland Rice Promising Lines in Acid Dry Land at Two Different Seasons (Running title: Rice Promising Lines in Acid Dry Land)

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Please check the editors comment in the text.

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ABSTRACT

Superior upland rice varieties can be obtained through the plant breeding process. Upland rice lines that are carried out from crossing have different potentials. The research aims to determine upland rice promising lines with high yields in acid-dry land. The study is conducted on Ultisol soil. The first season is in 2019 for F_6 lines, and the second is in 2021 for F_7 lines. The experimental methods use factorial Randomized Block Design (RBD). The treatment at the preliminary yield test use 5 lines 4 varieties, and 1 landrace. The advanced yield test uses 5 F_7 lines (selected from F_6 lines) and 5 types. Analysis data use ANOVA and LSI test. The result shows that lines GH8 and GH10 have the highest yields on acid-dry soils during two planting seasons. The GH_{10} line has a 7.20-9.53 kg/plot yield, and the GH_8 line has a 5.22-6.26 kg/plot. The highest yield potential was the GH_{10} line of 3.69-4.77 t/ha, more increased than Balok, Banyuasin, Danau Gaung, Inpago 8, and PBM-UBB1 varieties. GH_{10} and GH_8 lines are recommended as candidates for new superior varieties of upland rice that are adaptive to acid-dry soils.

Keywords: Acid dry land; High yield; Red rice; Ultisol

INTRODUCTION

Rice (*Oryza sativa* L.) is a primary food crop in Indonesia. The color of rice is caused by the content of anthocyanin pigment (Priya, Nelson, Ravichandra & Antony, 2019). Total anthocyanin content is higher than white rice (Agustin, Safitri, & Fatchiyah, 2021). Anthocyanins are phenolic compounds that function as antioxidants (Maulani, Sumardi, & Pancoro, 2019). Brown rice has different phenolic content (Gujral, Sharma, Kumar, & Singh, 2012), and white rice has different nutritions (Handajani, Sulandari, Purwidiani, & Zamroh, 2020). The public prefers red rice because it has higher nutrition, but it needs to be developed.

The capacity of food production requires agricultural land that is proportional to the Indonesian population (Rasyid & Kusumawaty, 2022). The main problem of agricultural land in Indonesia is caused by land conversion (Rochadi, Sadiyatunnimah & Salim, 2022). The arable land is getting narrower because used for roads, industry, houses, and others (Saputra, Tisnata, Sumarja, Triono, 2022). Agricultural transformation is currently being pursued in sub-optimal land areas to increase agricultural production (Riswani et al., 2022). Indonesian farmers have recently started to cultivate ultisol-type soil. Ultisol soil is impoverished in nutrients (Suryani et al., 2022). Soil types in the Bangka Belitung Archipelago Province are classified as Ultisol. Rice production in this province has not met the needs of its population, so it is necessary to increase rice production.

Assembly of ultisol-tolerant rice varieties to increase rice production. Ultisol soil contains 82.16% liat, pH 5.19, Org-C 18.8 g/kg, and Al-exch 1.92 me/100 g (Yulnafatmawita & Adrinal, 2014). It is essential to develop rice plants that are adaptive to acid-dry land. Due to drought stress, genotypes that cannot adapt to dry acid soil will inhibit vegetative growth and yield production (Tirtana et al., 2021). One rice variety that adapts to acid-dry land is Inpago 8 (Nazirah, Purba, Hanum, & Rauf, 2016). Genotipe yang beradaptasi pada tanah ultisol di bangka adalah PBM UBB 1, Danau Gaung dan 21B-57-21-21-23

(Mustikarini, Prayoga, Santi & Kurnia. 2022). PBM UBB1 is a brown rice variety. Danau Gaung dan 21B-57-21-21-23 is white rice.

A superior genotype can be obtained through the hybridization process. Hybridization of landrace Bangka rice with national varieties has been done to get lodging resistance lines. In further research, GH_3 and GH_4 from the F_6 lines can be used as candidates for new superior varieties (Mustikarini, Prayoga, Santi, Hairul, 2021). Rice plant lines that have been produced need to be tested on acid soils. The results of this study are expected to obtain lines that can adapt to Bangka ultisols. It is hoped that the test results for the two growing seasons will yield data on the average yield of the expected lines on ultisols. The research aims to determine upland rice promising lines that have high yields in acid-dry land

MATERIALS AND METHODS

The research was conducted in two experimental seasons in December 2020-April 2021, on Ultisol land in Universitas Bangka Belitung, Indonesia.

The research method used was the experimental procedure. The research design applied a randomized block design for each season. The treatment in the first season (preliminary yield test) used 10 upland rice lines (GH_1-GH_{10}) (Table 1). The treatment in the second season used 5 lines GH_3, GH4, GH_5, GH_8, and GH_{10} and 5 check varieties (Table 2). Lines GH_4 was the only remaining line of red rice, while the other lines were white rice. In 1 plot (experimental unit), there are 320 plants. The area of 1 plot is 20 m^2.

F_7 generation of rice plants was observed flag leaf length, plant height, number of productive tillers, panicle length, harvest age, number of unfilled grains, 1000 seed weight, yield per plot, and organoleptic tests. Data analysis used Fisher's test (α 5%) and the Least Significant Increase (LSI) test (formula 1).

$$LSI = {}_{(0,05;\,db)} \sqrt{\frac{2MSE}{r}} \qquad \text{..........1)}$$

Where: MSE = Mean Square Error; r = replication; $t_{(0,05;db)}$ = t table; α = 5%.

RESULTS AND DISCUSSION

A yield test was carried out identification of lines tolerant to dry acid soils. Plants that tolerate dry, acid soils show high growth and yield. Identification was carried out during two planting seasons. According to, Putriani, Yusnaini, dan Septiana (2022), Ultisol soil contains 9.14 ppm available-P, 0.98% Organic-C, and 10.78 cmol/kg CEC criteria very low. Ultisol soil in Bangka district has a pH of 4.5 and an Al-dd content of 3.02 cmolc/kg (Santi & Mustikarini 2011). Phototoxic aluminum (Al^{3+}) rapidly inhibits root growth, reducing water absorption and nutrients (Rahman, Lee, Ji, Kabir, Jones, & Lee. 2018). Plants with Al poisoning stunted growth and are abnormal (Herlinaa & Andarini 2022).

According to Michel et al. (2017), a preliminary yield test is carried out to determine the potential of superior lines. The initial yield test (season one) showed differences in character between the lines and the comparison varieties. All the lines at this stage had shorter plant heights than all the comparison varieties, except for the Banyuasin variety. The GH_2 line had the shortest plant height of 73.10 cm (Table 1). Rice can be easily identified through phenotype characteristics such as plant height (Widyayanti et al. 2020; Rahmawati, Santika, & Fitriyah 2021). The character of plant height < 105 cm is classified as a short plant. The F_6-F_7 generation lines are identified as having short plant height. The character of short plant height was inherited from the two parents of the cross, namely Banyuasin and Inpago 8. According to Huang et al. (2018), plants with short heights allocate more photosynthate to seeds. According to Rahmawati et al. (2021), reducing plant height is the main target to produce lodging resistance in rice.

Two lines had longer flag leaf lengths than the Banyuasin variety, namely GH_1 and GH_3 (Table 1). The number of productive tillers in rice plants affects the number of panicles produced. Early harvest age is thought to result from Inpago 8 and Balok offspring. Mustikarini et al. (2021) stated that the Hd gene controlled flowering and harvesting age. Weng et al. (2014) indicated that the flowering time gene Ghd7 regulates plant architecture, and genetic and environmental factors influence this regulation. Endo-Higashi & Izawa (2011), two essential flowering time genes in rice plants, *Hd1,* and *Ehd1*, also control panicle development. Early harvest age is the desired harvest age in the plant breeding process.

The test line with the longest panicle of 20.6 cm was GH_6, while the shortest, 15.5 cm, was GH_2 (Tabel 1). The longer the panicle, the more grain will be produced. Lines with better characteristics than the comparison varieties can be used as superior lines. The GH_4 line has a plant height of 71.32 cm. This line (GH_4) is classified as having a short plant height (Table 2). All rice plant lines tested had lower plant heights than the check variety. The GH2 line has the highest plant height of 93.74 cm.

Table 1. Results of LSI test of 17 rice genotypes of preliminary yield test results in generation F_6.

Genotypes	Plant height (cm)	Flag leaf length (cm)	Productive tiller number (tiller)	Flowering age (DAP)	Panicle length (cm)	Harvest age (DAP)	Yield per plot (kg)	Total grain (seeds)	Weight of 1000 seeds (g)
GH_1 (fxd)	86.25 acefg	30.39 b	11.75	79.7 bf	20.52 b	111.00 bf	3.82 f	878.00	25.32 abdef
GH_2 (axb)	73.10 acdefg	22.32	18.10 abcfg	63.4 abcdefgh	15.51	100.50 abcefh	3.48	1118.35 bf	25.39 abdef
GH_3 (fxd)	82.15 acdefg	32.04 bdh	15.90 acf	71.0 abcdefgh	19.30 b	104.00 bfh	4.93 bf	1732.05 bcdf	25.50 abdef
GH_4 (dxa)	96.60 acefg	29.69 b	13.30 c	77.9 abcfh	20.16 b	110.00 bf	5.55 bdf	1104.50 bf	26.38 abdef
GH_5 (axd)	88.20 acefg	26.28	16.30 acf	73.6 abcdefgh	18.79 b	114.00 bf	5.59 bdf	873.50	27.66 abdef
GH_6 (dxa)	86.80 acefg	25.49	12.25 c	73.3 abcdefgh	20.59 b	110.50 bf	2.84	1045.80 bf	24.11 abdef
GH_7 (axb)	88.85 acefg	26.80	13.65 c	75.5 abdefh	19.92 b	110.00 bf	4.15 bf	1082.90 bf	26.03 abdef
GH_8 (axb)	92.30 acefg	27.33	35.50 abcdefgh	71.8 abcdefgh	19.00 b	102.50 abfh	6.26 bdf	2923.75 abcdefgh	23.28 bdef
GH_9 (axb)	75.70 acdefg	19.56	17.80 abcf	75.8 abdefh	15.57	103.50 bfh	5.11 bf	1073.10 bf	24.77 abdef
GH_{10} (axb)	76.30 acdefg	24.39	47.70 abcdefgh	80.7 bf	16.48	112.50 bf	9.53 bcdfh	2546.15 abcdefgh	20.73 bf
Balok + LSI (a)	141.21	46.28	15.45	78.6	25.80	103.15	9.91	1885.28	24.10
Banyuasin + LSI (b)	56.76	29.23	17.30	84.5	16.80	115.15	3.83	932.38	20.23
Danau Gaung +LSI (c)	114.86	42.41	11.90	75.2	27.43	101.15	6.90	1274.58	29.76
Inpago 8 + LSI (d)	82.56	30.48	20.15	77.1	22.39	98.65	5.51	1421.73	22.44
Inpago 12 + LSI (e)	103.66	37.77	18.55	77.8	23.57	102.15	13.23	2417.53	23.13
PBM UBB-1 + LSI (f)	151.41	40.64	14.60	86.9	23.61	122.15	3.63	968.83	18.79
Rindang 1 + LSI (g)	103.56	37.21	18.00	74.6	25.83	97.65	11.53	2116.83	28.48
$\bar{x}g$+LSI (h)	**72.49**	**30.66**	**26.33**	**78.1**	**20.61**	**104.50**	**8.06**	**1918.39**	**27.89**
LSI	**12.14**	**4.23**	**6.10**	**3.9**	**2.03**	**3.35**	**2.93**	**480.58**	**2.98**

Remarks: $\bar{x}g$ = Average offspring genotype lines; The letter behind the number indicates that the test line is better than (a) Balok, (b) Banyuasin, (c) Danau Gaung, (d) Inpago 8, (e) Inpago 12, (f) Rindang 1, and (g) the average genotype of the lineage; The letters in brackets that follow the test line code are the parent of the cross; The test line was better than the comparison on the characters of flag leaf length, number of productive tillers, panicle length, production per plot, total grain count, and 1000 grain weight if the test line check value + LSI, while on the character of plant height, harvest age, and loss if the test line check value – LSI (α = 5%).

Table 2. Results of LSI test of 9 rice genotypes of preliminary yield test results in generation F_6 and F_7 (second seasons).

Genotypes	Plant height (cm)	Flag leaf length (cm)	Productive tiller number (tiller)	Panicle length (cm)	Harvest age (DAP)	Total grain (seeds)	Yield per plot (kg)	Weight of 1000 seeds (g)
GH_3	79.12 abcde	31.83 b	23.63 ac	19.89	114.1	1338.47	4.31	28.85
GH_4	93.74 acd	26.91	17.50	20.48	111.25	1012.29	4.05	34.39
GH_5	95.95 acd	24.61	31.38 abcde	21.13	107.5 abe	1942.46 ab	5.22	29.41
GH_8	71.32 abcde	22.39	42.00 abcde	18.10	113.05	1737.88 b	7.20	23.51
GH_{10}	83.67 abcde	25.85	21.73 a	20.55	114	808.71	4.69	27.53
Danau Gaung + LSI (a)	113.44	43.40	19.90	30.48	109.92	1895.07	14.02	84.51
Inpago 8 + LSI (b)	88.27	30.88	23.78	25.57	107.95	1659.52	8.01	63.83
Inpago 12 + LSI (c)	98.62	36.56	23.55	25.85	105.17	2550.90	13.23	83.83
Rindang + LSI (d)	103.67	38.46	25.15	27.68	105.67	2111.04	16.59	63.08
$\bar{x}g$+LSI (e)	**83.83**	**34.02**	**29.93**	**24.88**	**107.72**	**1963.11**	**10.63**	**57.77**
LSI	**14.66**	**5.06**	**8.15**	**2.83**	**3.83**	**522.34**	**3.67**	**16.20**

Remarks: $\bar{x}g$ = Average offspring genotype lines; The letter behind the number indicates that the test line is better than (a) Danau Gaung, (b) Inpago 12, (c) Inpago 8, (d) Rindang 1, and (e) the average genotype of the lineage; The letters in brackets that follow the test line code are the parent of the cross; The test line was better than the comparison on the characters of flag leaf length, number of productive tillers, panicle length, production per plot, total grain count, and 1000 grain weight if the test line check value + LSI, while on the character of plant height, harvest age, and loss if the test line check value – LSI (α = 5%).

Early harvest age is the desired harvest age in the plant breeding process. The speedy age of rice harvest also does not necessarily increase productivity. The character of the total grain amount is known based on the total number of grains in one plant clump, including empty grain. The total grain number of test lines ranged from 873.5-2923.75, with the highest total grain number of GH_8 (Table 1). A high amount of grain will also be followed by a high crop production. The weight of 1000 seeds of the lines tested showed a higher value than the parents, namely 23.3-27.7 g. The line with the lowest 1000 seed weight was GH_{10}, with an average weight of 20.7 g. The magnitude of the importance of 1000 seeds is not necessarily accompanied by high production.

Mardiah et al. (2017) stated that the colors consumers like are bright, while consumers do not like dull colors. The rice color of line GH_{10} is preferred because it is red compared to other lines (Fig. 1). A pair of genes belonging to each test line is a combination of two parental alleles. The dominant allele will be expressed, while the recessive allele that is not expressed will still be inherited in the gametes formed in the offspring. Following the dominant trait, one of the parents will produce a white epidermis, while the recessive trait will produce less red epidermis. The Rc gene sequence controls the red color in rice. The OSB1 gene sequence controls black rice, while white rice is controlled by the *DFR* gene (Lim & Ha, 2013).

Lines GH_{10} with a yield of 9.53 kg/plot and Lines GH_8 with a yield of 6.26 kg/plot. The GH_{10} is the line that has the highest yield. The high yield of the GH_{10} lines was supported by the character of yield per plot, productive tillers number, plant height, and harvest age. Mustikarini et al. (2021) added Long panicles have a more significant burden so that rice stalks become curved and prone to fall. It makes long panicles not necessarily able to increase production. The GH_{10} lines have the highest yield in two growing seasons. The second highest yield was GH_8 lines. The GH_{10} line is classified as brown rice.

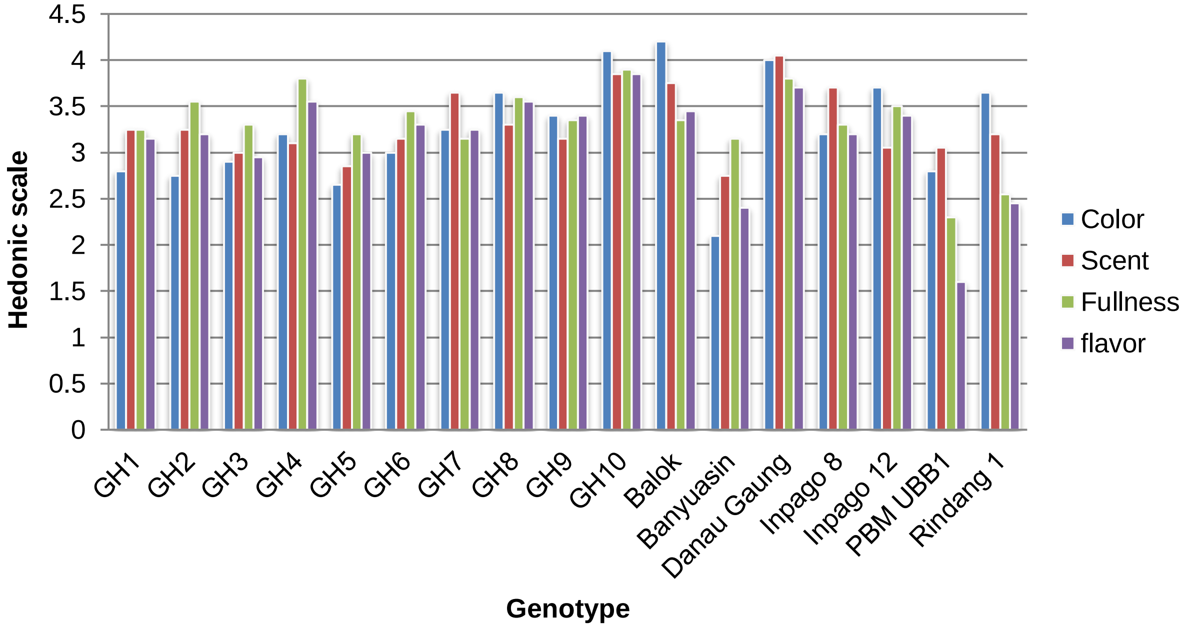

Fig. 1. Panelist's Level of Preference for Color, Aroma, Fluffiness and Taste of Rice

CONCLUSION AND SUGGESTION

Lines GH_8 and GH_{10} had the highest acid-dry soil yield during two planting seasons. The GH_{10} line had a 7.20-9.53 kg/plot yield, and the GH8 line had a 5.22-6.26 kg/plot. The highest yield potential was the GH_{10} line of 3.69-4.77 t/ha, more increased than Balok, Banyuasin, Danau Gaung, Inpago 8, and PBM-UBB1 varieties. GH_{10} and GH_8 lines are recommended as candidates for superior varieties of upland rice that are adaptive to acid-dry soils.

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REFERENCES

Agustin, A. T., Safitri, A., & Fatchiyah, F. (2021). Java red rice (Oryza sativa l.) nutritional value and anthocyanin profiles and its potential role as antioxidant and anti-diabetic. *Indonesian Journal of Chemistry*, *21*(4), 968–978. https://doi.org/10.22146/ijc.64509

Endo-Higashi, N., & Izawa, T. (2011). Flowering time genes heading date 1 and early heading date 1 together control panicle development in rice. *Plant and Cell Physiology*, *52*(6), 1083–1094. https://doi.org/10.1093/pcp/pcr059

Gujral, H. S., Sharma, P., Kumar, A., & Singh, B. (2012). Total phenolic content and antioxidant activity of extruded brown rice. *International Journal of Food Properties*, *15*(2), 301–311. https://doi.org/10.1080/10942912.2010.483617

Handajani, S., Sulandari, L., Purwidiani, N., & Zamroh, beta seftiyany. (2020). Study of Rice Analog from Cassava–Soybean and Processed Product. *ICONHOMECS 2019*, *406*(Iconhomecs 2019), 287–297. https://doi.org/10.2991/assehr.k.200218.046

Herlina, L., & Andarini, Y. N. (2022). Screening and Evaluation of 100 Upland Rice Accessions for Developing High-Yielding Upland Rice Varieties Tolerant against Acid Soil. In *AIP Conference Proceedings* (Vol. 2462, Nomor January). https://doi.org/10.1063/12.0008934

Huang, J., Li, J., Zhou, J., Wang, L., Yang, S., Hurst, L. D., Li, W. H., & Tian, D. (2018). Identifying a large number of high-yield genes in rice by pedigree analysis, whole-genome sequencing, and CRISPR-Cas9 gene knockout. *Proceedings of the National Academy of Sciences of the United States of America*, *115*(32), E7559–E7567. https://doi.org/10.1073/pnas.1806110115

Lim, S. H., & Ha, S. H. (2013). Marker development for the identification of rice seed color. *Plant Biotechnology Reports*, *7*(3), 391–398. https://doi.org/10.1007/s11816-013-0276-1

Mardiah, Z., Septianingrum, E., Handoko, dody d., & Kusbiantoro, B. (2017). Improvement of red rice eating quality through one-time polishing process and evaluation on its phenolic and anthocyanin content. *International Journal of Agriculture, Forestry and Plantation*, *5*, 23–24.

Maulani, R. R., Sumardi, D., & Pancoro, A. (2019). Total flavonoids and anthocyanins content of pigmented rice. *Drug Invention Today* |, *12*(2), 369–373.

Michel, S., Ametz, C., Gungor, H., Akgöl, B., Epure, D., Grausgruber, H., Löschenberger, F., & Buerstmayr, H. (2017). Genomic assisted selection for enhancing line breeding: merging genomic and phenotypic selection in winter wheat breeding programs with preliminary yield trials. *Theoretical and Applied Genetics*, *130*(2), 363–376. https://doi.org/10.1007/s00122-016-2818-8

Mustikarini, E. D., Prayoga, G. I., Santi, R., & Hairul, H. (2021). Genetic parameters of F6 upland rice with lodging resistance derived from landraces x national varieties. *IOP Conference Series: Earth and Environmental Science*, *741*(1), 1–7. https://doi.org/10.1088/1755-1315/741/1/012010

Mustikarini, E. D., Prayoga, G. I., Santi, R., & Wardani, K. (2022). Adaptation test for upland rice genotypes in Balunijuk village rice fields with ultisol type. *IOP Conference Series: Earth and Environmental Science*, *1108*(1). https://doi.org/10.1088/1755-1315/1108/1/012026

Nazirah, L., Purba, E., Hanum, C., & Rauf, A. (2016). Characterization of Tolerant Upland Rice to Drought on Rooting and Physiology. *Journal of Agriculture and Life Sciences*, *3*(2), 43–49.

Putriani, S. S., Yusnaini, S., & Septiana, L. M. (2022). *Aplikasi Biochar dan Pupuk P Terhadap Ketersediaan dan Serapan P pada Tanaman Jagung Manis (Zea mays Saccharata Sturt) di Tanah Ultisol*. *10*(4), 615–626. http://dx.doi.org/10.23960/jat.v10i4.6447

Rahman, M. A., Lee, S. H., Ji, H. C., Kabir, A. H., Jones, C. S., & Lee, K. W. (2018). Importance of mineral nutrition for mitigating aluminum toxicity in plants on acidic soils: Current status and opportunities. *International*

Journal of Molecular Sciences, *19*(10). https://doi.org/10.3390/ijms19103073
Rahmawati, D., Santika, P., & Fitriyah, A. (2021). Characterization of Several Rice (Oryza sativa L.) Varieties as ahttps://proceedings.polije.ac.id/index.php/food-science/article/download/140/193/336
Rasyid, T. H., & Kusumawaty, Y. (2022). Omnibus Law and the Challenges of the Indonesian Agricultural Sector: an Islamic Perspective. *Jurnal Kajian Peradaban Islam*, *5*(1), 49–61. https://doi.org/10.47076/jkpis.v5i1.119
Rathna Priya, T. S., Eliazer Nelson, A. R. L., Ravichandran, K., & Antony, U. (2019). Nutritional and functional properties of coloured rice varieties of South India: A review. *Journal of Ethnic Foods*, *6*(1), 1–11. https://doi.org/10.1186/s42779-019-0017-3
Riswani, Yunita, & Thirtawati. (2022). Prospects and Feasibility of Implementation of Agricultural Transformation for Food Crops on Sub Optimal Land in Ogan Ilir Regency, South Sumatra. *IOP Conference Series: Earth and Environmental Science*, *995*(1). https://doi.org/10.1088/1755-1315/995/1/012016
Rochadi, A. S., Sadiyatunnimah, S., & Salim, K. (2022). Agricultural Land Conversion and Human Trafficking in Northern Java Island, Indonesia. *Asian Journal of Agriculture and Rural Development*, *12*(3), 173–181. https://doi.org/10.55493/5005.v12i3.4563
Santi, R., & Mustikarini, E.D. (2011). Potensi Hasil Galur dan Varietas Kedelai di Lahan Podsolid Merah Kuning (PMK) Bangka. Enviagro. 4(1).11-16. Mohon diganti dengan jurnal scopus indexed
Saputra, R.A., Tisnata, H.S., Sumarja, F.X., Triono, A. 2022. Agricultural land conversion for housing development and sustainable food agricultural land. Technium Social Sciences Journal. 37. 216-223. Mohon diganti dengan jurnal scopus indexed

Suryani, E., Idris, H., Nurmansyah, & Nasir, N. (2022). Effect of Harvest Interval on the Productivity of Three Varieties of Citronela Grass Planted on Ultisol Soil. *IOP Conference Series: Earth and Environmental Science*, *1097*(1), 012007. https://doi.org/10.1088/1755-1315/1097/1/012007
Tirtana, A., Purwoko, B. S., Dewi, I. S., & Trikoesoemaningtyas. (2021). Selection of upland rice lines in advanced yield trials and response to abiotic stress. *Biodiversitas*, *22*(10), 4694–4703. https://doi.org/10.13057/biodiv/d221063
Weng, X., Wang, L., Wang, J., Hu, Y., Du, H., Xu, C., Xing, Y., Li, X., Xiao, J., & Zhang, Q. (2014). Grain Number, Plant Height, and Heading Date7 is a central regulator of growth, development, and stress response. *Plant Physiology*, *164*(2), 735–747. https://doi.org/10.1104/pp.113.231308
Widyayanti, S., Hidayatun, N., Kurniawan, H., Kristamtini, & Sudarmaji. (2020). Local rice genetic resource management in AIAT Yogyakarta: For supporting industrial revolution 4.0. *AIP Conference Proceedings*, *2260*. https://doi.org/10.1063/5.0016403
Yulnafatmawita, & Adrinal. (2014). Physical characteristics of ultisols and the impact on soil loss during soybean (Glycine max Merr) cultivation in a wet tropical area. *Agrivita*, *36*(1), 57–64. https://doi.org/10.17503/agrivita-2014-36-1-p057-064

COVER PAGE

I. Potential of Upland Rice Promising Lines in Acid Dry Land at Two Different Seasons.

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VII. Acknowledgement

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2. The candidates should come from different institutions with authors *(especially from different countries)*

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Potential of Upland Rice Promising Lines in Acid Dry Land at Two Different Seasons

ABSTRACT (150-200 words)

Superior upland rice varieties can be obtained through plant breeding process. Upland rice lines that carried out from crossing have different potentials. The aim of the research was to determine upland rice promising lines that have high yields in acid dry land. The research was conducted on Ultisol soil. The first seasons was done in 2019 for F_6 lines and the second season was done in 2021 for F_7 lines. The experimental methods used two faktorial Randomized Block Design (RBD). The treatment at the preliminary yield test used 5 lines, 4 varieties and 1 landrace as comparison plant. The advanced yield test used 5 F_7 lines (selected from F_6 lines) and 5 varieties as comparison plant. Analysis data used ANOVA and LSI test. The result showed that the F_6 lines that have higher yield than the comparison plant are lines of GH_4 (4.75 tons/ha) and GH_3 (3.15 tons/ha). The yield of F_6 and F_7 lines ranged from 2.01-3.6 tons/ha. The F_7 lines GH_4 and GH_5 shows the higher yield than comparison plant. Based on these results, lines GH_4 (brown rice) and GH_3 (white rice) were recommended as candidates for high-yielding adaptive upland rice varieties in acid dry land.

Keywords: Acid dry land; Advanced yield test; Preliminary yield test;Upland Rice; Yield.

INTRODUCTION

Rice (*Oryza sativa* L.) is a main food crop consumed by 90% of total population in Indonesia (Donggulo, Lapanjang, & Made, 2017). Rice can be classified on the color of the rice. The color of rice is categorized into three groups, namely white rice, brown rice and black rice (Abdullah, 2017). The color of rice is due to the content of anthocyanin pigments. Phenolic compounds that belong to the group of flavonoids that function as antioxidants are anthocyanin substances (Yurnawati, Aryana, & Sutresna, 2018). The anthocyanin-rich fraction used as functional dyes or foodstuffs is located in a particular layer of rice grains, which can be separated (Kim et al., 2013). Pramai & Jiamyangyuen (2016), the pigmented Thai rice varieties, including red and black color and non-pigmented rice (white), were determined for color and antioxidant properties. Maulani, Sumardi, & Pancoro, (2019), anthocyanins are a phenolic compound that belongs to the flavonoid group which plays an important role, both for the plant itself and human health, namely as an antioxidant. Gujral, Sharma, Kumar, & Singh, (2012), the total phenolic content in the brown rice from the three cultivars ranged from 0.803–0.885 mg ferulic acid equivalent/g flour. White rice per 100 g can contain nutrients in the form of energy 357 cal, protein 8.4 g, fat 1.7 g, carbohydrates 77.1 g, calcium 147 mg, phosphorus 81 mg and thiamine 0.2 mg (Handajani et al., 2020).

Most soil types in Bangka Belitung Province are classified as ultisol soil with acid dry characteristic. Ultisol soil types have low fertility, such as acid soil pH (4.54), C-organic, available P, Mg-dd, Ca-dd, low CEC and KB, total N, low K-dd and Na-dd, while the C/N ratio is moderate (Syukri, Nelvia, & Adiwirman, 2019). Developing of rice plant that adaptive to acid dry land is important. Genotypes that are not able to adapt to dry acid soil will inhibit vegetative growth and yield production, due to drought stress (Tirtana et al., 2021). One of rice varieties known able to adapt to acid dry land are Inpago 8 (Nazirah, Purba, Hanum, & Rauf, 2016).

Superior genotype can be obtained through the hybridization process. Hybridization of landrace Bangka rice with national varieties has been done to get a lodging resistance lines with high yielding and adaptive to acid dry land (Mustikarini et al., 2019). Selection on F_4 generation were obtained 56 high yielding lodging resistance lines (Mustikarini, Prayoga, & Aprilian, 2020). In further research, GH_3 and GH_4 from the F_6 lines can be used as candidates for new superior varieties (Mustikarini et al., 2021). The next stage that must be carried out is preliminary and advance yield test.

The yield tests are needed to determine the potential yield of plants (Syukur et al., 2012). The yield test is divided into two stages, namely preliminary and advanced yield tests. Preliminary yield tests were carried out on the F_6 and F_7 generations (Syukur et al. 2018), and the selected lines will proceed to the advanced yield test in the next season. According to Fatimaturrohmah et al. (2016), the results of the yield test are used as a reference for the multilocation test. Based on the description, this research aims to get promising lines with high yields in ultisol land.

MATERIALS AND METHODS

The research was conducted in two experimental seasons, the first season in 2020 and the second in 2021. The research was carried out on ultisol land in experimental and research station, Universitas Bangka Belitung.

The research used Randomized Block Design (RBD) for each season. The treatment at the first season (preliminary yield test) used 10 F_6 lines which were the result of a cross between landraces with national varieties. The treatment at the second season used 5 F_7 upland rice lines GH_1 (19I-06-09-23-03), GH_2 (21B-57-21-21-23), GH_3 (23F-04-10-18-18), GH_4 (23A-56-20-07-20) and GH_5 (23A-56-22-20-05) and 5 check varieties D_g (Danau Gaung), I_8 (Inpago 8), I_{12} (Inpago 12), and R_i (Rindang). Lines GH_4 is the only remaining lines of red rice, while the other lines are white rice. Plot size was 4 x 5 m with 320 plants for each plot.

The characters observed in the F_7 generation lines are plant height (cm), flag leaf length (cm), panicle length (cm), number of productive tillers, harvest age (DAP), yield per plot (kg), number of grains filled, weight of 1000 seeds (g), and organoleptic test. Data were analyzed using the F-test at α 5% and Least Significant Increase (LSI) test (Ruchjaniningsih & Thamrin, 2016).

$$LSI = {}_{(0,05;db)} \sqrt{\frac{2MSE}{r}}$$

notes: : $t_{(0,05;db)}$ = t table; α = 5%

MSE = Mean Square Error

r = replication

RESULTS AND DISCUSSION

Preliminary yield test was conducted to determine the potential of 10 lines F_6 that have high yield and lodging resistance. Michel et al., (2017), preliminary yield test was carried out to determine the potential of superior lines.

The results of each F_6 line showed different characters to the comparison varieties. The difference in plant growth characters is caused by differences in the genetic characteristics of the plant itself (Syafi'ie & Damanhuri, 2018). Afifah et al., (2020) stated, if the value of the test genotype is greater than the comparison in the *Least Significant Increase* (LSI) follow-up test, it shows that the test line has a good appearance and increases the chance of selection as a superior genotype. All the lines at this stage had shorter plant heights than all the comparison varieties, except for the Banyuasin variety. The F_6 lines which had the shortest plant height was in line 23A-56-13-25-13 with a plant height of 73.10 cm (Table 1). The character of plant height <105 cm is classified as a short plant. The F6 and F7 lineages showed that they were classified as plants with short plant heights. The short plant characters came from the elders of Banyuasin and Inpago 8. Mustikarini *et al*. Mustikarini, Prayoga, & Aprilian (2020), stated that the diversity of plant heights in the test line had the influence of genes inherited from parents, namely the *Sd1-Sd7* gene. Rice plants with short stem phenotypes are not easy to fall if the wind blows, especially when the rice plants enter the fruit filling phase (Lestari, Kartahadimaja, & Hakim, 2017). Rice plants with shorter plant heights, so that the resulting photosynthesis results are allocated more for seed formation (Huang et al., 2018).

There were 2 lines which had longer flag leaf length than the Banyuasin variety, namely 19I-06-30-17-11 and 19I-06-09-23-03 (Table 1). Flag leaf length has a major effect on rice production (Rahmah & Aswidinnoor, 2014). The number of productive tillers in rice plants affects the number of panicles that will be produced.

Lestari, Kartahadimaja, & Hakim, (2017) stated, rice harvesting age was categorized into deep (>151 Days After Seedling/HSS), medium (125-150 DAS), early (105-124 DAS), very early (90-104 DAS) and super early (<90 HSS). Early harvest age is thought to be the result of offspring from Inpago 8 and Belok. Mustikarini et al., (2021) stated that flowering and harvesting age were controlled by the *Hd* gene. Weng et al., (2014), indicated that the flowering time gene Ghd7 regulates plant architecture as well, and this regulation is influenced by both genetic and environmental factors. Endo-Higashi & Izawa (2011), two key flowering time genes in rice plants, *Hd1* and *Ehd1*, also control panicle development. The desired harvest age in the plant breeding process is the early harvest age. Nurazizah, Hairmansis, & Damanhuri, (2019) adds, short harvesting ages have low yield potential because plants do not have enough time to use sunlight and nutrients in the soil.

The test line with the longest panicle of 20.6 was GH_2 (21B-57-21-21-25), while the shortest 15.5 cm was 23A-56-13-25-13 (Tabel 1). Panicle length affects the amount of grain that will be produced (Nurazizah, Hairmansis, & Damanhuri, (2019). The longer the panicle, the more grain will be produced.

Based on the LSI test, it will potentially be a superior genotype is a larger F7 rice line than the check rice variety (Carsono et al., 2020). In the LSI test, the genotype with a higher score than the variety indicated a line that performed well and could become a superior genotype (Afifah et al., 2020). The rice line that has the shortest plant height is GH_4 which is 71.32 cm (Table 2). The height of the F7 line plant that falls into the moderate category found in GH_2 strains is 93.74 cm. The plant's height of 5 (five) lines indicates shorter than the check variety. Plant height is influenced by cultivar genetic factors (Damascus et al., 2012). Plant growth that is not uniform is influenced by genetic variances, where each cultivar has special characteristics and traits (Suete, Samudin, &Hasanah, 2017).

The desired harvest age in the plant breeding process is the early harvest age. The fast harvest age is able to increase the rice harvest period, so that rice productivity can be increased (Supriyanti, Supriyanta, & Kristamtini, 2015). The very fast age of rice harvest also does not necessarily increase productivity. The character of the total grain amount is known based on the total number of grain in one plant clump including empty grain. Total grain number of test lines ranged from 873.5-2923.75 grain with the highest total grain number was 23A-56-20-07-20 (Table 1). Syafi'ie & Damanhuri, (2018), stated that the number of seeds per clump can be influenced by the character of the number of tillers and panicle length, the higher the two characters, the higher the number of seeds per clump. Kartina, Wibowo, & Rumanti, (2017) stated, the amount of grain produced will affect production. A high amount of grain will be followed by a high crop production as well. The character of the weight of 1000 seeds of the test line seeds was generally heavier than all the parents in the range of 23.3-27.7 g, except for the 23A-56-22-20-05 (20.7 g) line. The magnitude of the weight of 1000 seeds is not necessarily accompanied by high production.

Supriyanti, Supriyanta, & Kristamtini, (2015) stated, that the color of rice is grouped into white rice, which is called white rice, red and brown colors are called red rice, while purple varies with black rice. Mardiah et al., (2017) stated, the colors that consumers like are bright colors, while dull colors are not liked by consumers. Diagram 1 shows the rice color of line 23A-56-22-20-05 which is preferred because it is red compared to other lines. The cause of the color difference is due to the enactment of Mendel's law I and Mendel's law II (Afandi, Lita, & Sri, 2014). A pair of genes belonging to each test line is a combination of two parental alleles combination. The dominant allele will be expressed, while the recessive allele that is not expressed will still be inherited in the gametes formed in the offspring. In accordance with the dominant trait, one of the parents will produce more white epidermis, while the recessive trait will produce less red epidermis. The red color in rice is controlled by the *Rc* gene sequence, black rice is controlled by the *OSB1* gene *sequence*, while white rice is controlled by the *DFR* gene (Lim & Ha, 2013).

Mustikarini et al., (2021) added, long panicles have a greater burden so that rice stalks become curved and prone to fall. This makes long panicles not necessarily able to increase production. Farmers prefer medium panicle length to long and short panicles (Perdani et al., 2020). Line F_7 23A-56-22-20-05 with a production of 9.5 kg/plot (4.75 tons/ha) has the potential to be developed. Line 23A-56-20-07-20 had a yield close to the national productivity of 6.3 kg/plot (3.15 tons/ha). The F_7 line that showed the highest yield was GH_4 (23A-56-22-20-05). Line of 23A-56-22-20-05 resulted has advantages on the plant height, productive tiller number harvest age, and yield per plot. This line is a type of upland red rice. Galur GH_4 (23A-56-22-20-05) berdasarkan hasil percobaan selama dua musim memiliki hasil produksi lebih tinggi dibandingkan dengan galur lainnya. Galur tersebut merupakan padi gogo beras merah .The second highest yield was GH_3 (23A-56-20-07-20) line with the production approximately 2.61 tons/ha of rice yield. Galur GH3 selain merupakan galur yang memiliki tingkat produksi kedua tertinggi, juga memiliki keunggulan pada parameter bobot 1000 biji, yaitu seberat 29.41g/1000 biji.

CONCLUSIONS AND SUGGESTION

Two F_6 lines which have higher yield than the comparison plant are lines 23A-56-22-20-05 and 23A-56-20-07-20. The line 23A-56-22-20-05 (4.75 tons/ha) have higher yield than Banyuasin, Danau Gaung, Inpago 8 and PBM UBB-1, where line 23A-56-20-07-20 (3.15 tons/ha) higher than Banyuasin, Inpago 8 and PBM UBB-1. The yield of F_7 lines or Second season ranged from 9.17-12.87 kg/plot, or equivalent to 4.58-6.43 tons/ha. The F_6 and F_7 lines GH_4 (23A-56-22-20-05) and GH_3 (23A-56-20-07-

20), shows the higher yield than comparison plant, so lines GH_4 (brown rice) and GH_3 (white rice) were recommended as candidates for high-yielding adaptive upland rice varieties in acid dry land. Hasil produksi dari gabungan dua musim (f6 dan f7) memiliki rata-rata produksi berkisar 4.05-7.20 kg/plot, or equivalent to 2.01-3.6 tons/ha.

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REFERENCES

Abdullah, B. (2017). Peningkatan Kadar Antosianin Beras Merah dan Beras Hitam Melalui Biofortifikasi / Increasing Anthocyanin of Red and Black Rice through Biofortification. *Jurnal Penelitian dan Pengembangan Pertanian*, *36*(2), 91–98. https://doi.org/10.21082/jp3.v36n2.2017.p91-98

Afandi, S. W., Lita, S., & Sri, P. L. (2014). Penampilan Tujuh Genotip Padi (*Oryza Sativa* L.) Hibrida Japonica pada Dua Musim Tanam The Performance The Performance Of The Seven Japonica Hybrid Rice (*Oryza sativa* L) Genotypes In Two Seasons. *Jurnal Produksi Tanaman*, *2*(7), 583–591.

Afifah, Z., Carsono, N., Sari, S., & Anas, A. (2020). Uji Daya Hasil dan Seleksi Famili Padi Generasi F4 dan F6 Hasil Persilangan Sintanur x PTB 33 dan Pandanwangi x PTB 33 di Jatinangor. *AGROSAINSTEK: Jurnal Ilmu dan Teknologi Pertanian*, *4*(1), 28–34. https://doi.org/10.33019/agrosainstek.v4i1.96

Carsono, N., Fitria, N., Sari, S., & Ruswandi, D. (2020). Karakterisasi Mutu Fisik Bulir 30 Genotipe Padi Generasi F5 Hasil Seleksi dari Persilangan Sintanur X PTB33 dan Pandanwangi X PTB33. *Agrikultura*, *31*(3), 166–173. https://doi.org/10.24198/agrikultura.v31i3.29779

Damanik, R. I., Ismail, M. R., Shamsuddin, Z., Othman, S., Zain, A. M., & Maziah, M. (2012). Response of Antioxidant Systems in Oxygen Deprived Suspension Cultures of Rice (*Oryza sativa* L.). *Plant Growth Regulation*, *67*(1), 83–92. https://doi.org/10.1007/s10725-012-9668-4

Donggulo, C. V, Lapanjang, I. M., & Made, U. (2017). Pertumbuhan Dan Hasil Tanaman Padi (*Oryza sativa* L) Pada Berbagai Pola Jajar Legowo Dan Jarak Tanam Growth And Yield Of Rice (*Oryza sativa* L.) Under Different Jajar Legowo System And Planting Space. *J. Agroland*, *24*(1), 27–35.

Endo-Higashi, N., & Izawa, T. (2011). Flowering Time Genes Heading Date 1 and Early Heading Date 1 Together Control Panicle Development in Rice. *Plant and Cell Physiology*, *52*(6), 1083–1094. https://doi.org/10.1093/pcp/pcr059

Fatimaturrohmah, S., Rumanti, I. A., Soegianto, A., & Damanhuri, D. (2016). Hibrida di Dataran Medium Advance Yield Trials Some Genotype Of Rice Hybrid (*Oryza sativa* L.) at Medium Land. *Jurnal Produksi Tanaman*, *4*(2), 129–136.

Gujral, H. S., Sharma, P., Kumar, A., & Singh, B. (2012). Total Phenolic Content and Antioxidant Activity of Extruded Brown Rice. *International Journal of Food Properties*, *15*(2), 301–311. https://doi.org/10.1080/10942912.2010.483617

Handajani, S., Sulandari, L., Purwidiani, N., & Zamroh, beta seftiyany. (2020). Study of Rice Analog from Cassava–Soybean and Processed Product. *ICONHOMECS 2019*, *406* (Iconhomecs 2019), 287–297. https://doi.org/10.2991/assehr.k.200218.046

Huang, J., Li, J., Zhou, J., Wang, L., Yang, S., Hurst, L. D., Li, W. H., & Tian, D. (2018). Identifying a Large Number of High-Yield Genes in Rice by Pedigree Analysis, Whole-Genome Sequencing, and CRISPR-Cas9 Gene Knockout. *Proceedings of the National Academy of Sciences of the United States of America*, *115*(32), E7559–E7567. https://doi.org/10.1073/pnas.1806110115

Kartina, N., Wibowo, B. P., & Rumanti, I. A. (2017). Korelasi Hasil Gabah dan Komponen Hasil Padi Hibrida Correlation of Grain Yield and Yield Components of Hybrid Rice Varieties. *Jurnal Penelitian Pertanian Tanaman Pangan*, *1*(1), 11–20. https://www.neliti.com/id/publications/139097/korelasi-hasil-gabah-dan-komponen-hasil-padi-hibrida.

Kim, S.-K., Shin, J.-H., Kang, D.-K., Kim, S.-Y., & Park, S.-Y. (2013). Changes of Anthocyanidin Content and Brown Rice Yield in Three Pigmented Rice Varieties Among Different Transplanting and Harvesting Times. *Korean Journal of Crop Science*, *58*(1), 28–35. https://doi.org/10.7740/kjcs.2013.58.1.028

Lestari, A. T., Kartahadimaja, J., & Hakim, N. A. (2017). Uji Daya Hasil Empat Galur Padi Generasi Ke Empat di Lahan Politeknik Negeri Lampung. *Jurnal Penelitian Pertanian Terapan*, *17*(3), 165.

https://doi.org/10.25181/jppt.v17i3.298
Lim, S. H., & Ha, S. H. (2013). Marker Development for The Identification of Rice Seed Color. *Plant Biotechnology Reports*, *7*(3), 391–398. https://doi.org/10.1007/s11816-013-0276-1
Mardiah, Z., Septianingrum, E., Handoko, dody d., & Kusbiantoro, B. (2017). No Titleimprovement of Red Rice Eating Quality Through One-Time Polishing Process and Evaluation on its Phenolic And Anthocyanin Content. *International Journal of Agriculture, Forestry and Plantation*, *Vol. 5*, 23–24.
Maulani, R. R., Sumardi, D., & Pancoro, A. (2019). Total Flavonoids and Anthocyanins Content of Pigmented Rice. *Drug Invention Today* |, *12*(2), 369–373.
Michel, S., Ametz, C., Gungor, H., Akgöl, B., Epure, D., Grausgruber, H., Löschenberger, F., & Buerstmayr, H. (2017). Genomic Assisted Selection for Enhancing Line Breeding: Merging Genomic and Phenotypic Selection in Winter Wheat Breeding Programs with Preliminary Yield Trials. *Theoretical and Applied Genetics*, *130*(2), 363–376. https://doi.org/10.1007/s00122-016-2818-8.
Mustikarini, E. D., Prayoga, G. I., Santi, R., & Hairul, H. (2021). Genetic Parameters of F6 Upland Rice with Lodging Resistance Derived from Landraces X National Varieties. *IOP Conference Series: Earth and Environmental Science*, *741*(1), 1–7. https://doi.org/10.1088/1755-1315/741/1/012010.
Mustikarini, E. D., Prayoga, G. I., Santi, R., Nurqirani, Z., & Saragi, H. (2019). Genetic Parameter Contributing to Lodging Resistance of F2 Population in Red Rice. *IOP Conference Series: Earth and Environmental Science*, *334*(1), 1–8. https://doi.org/10.1088/1755-1315/334/1/012066
Mustikarini, Eries Dyah, Prayoga, G. I., & Aprilian, B. (2020). Seleksi Galur Generasi F4 Padi Beras Merah Tahan Rebah. *AGROSAINSTEK: Jurnal Ilmu dan Teknologi Pertanian*, *4*(1), 1–9. https://doi.org/10.33019/agrosainstek.v4i1.105
Nazirah, L., Purba, E., Hanum, C., & Rauf, A. (2016). Characterization of Tolerant Upland Rice to Drought on Rooting and Physiology. *Journal of Agriculture and Life Sciences*, *3*(2), 43–49.
Nurazizah, A., Hairmansis, A., & Damanhuri. (2019). Uji Daya Hasil Dan Pendugaan Parameter Genetik Karakter Agronomi Genotipe Padi Gogo (*Oryza sativa* L.). *Jurnal Produksi Tanaman*, *7*(12), 2223–2229.
Perdani, A. Y., Mulyaningsih, E. S., Sulistyowati, Y., Suherman, S., Sanjaya, I., & Prastyo, M. (2020). Preferensi Petani terhadap 15 Galur Padi Gogo Ditabalong-Kalimantan Selatan. *Jurnal Agrotek Tropika*, *8*(1), 131. https://doi.org/10.23960/jat.v8i1.3691
Pramai, P., & Jiamyangyuen, S. (2016). Chemometric Classification of Pigmented Rice Varieties Based on Antioxidative Properties in Relation to Color. *Songklanakarin Journal of Science and Technology*, *38*(5), 463–472. https://doi.org/10.14456/sjst-psu.2016.62
Rahmah, R., & Aswidinnoor, H. (2014). Uji Daya Hasil Lanjutan 30 Galur Padi Tipe Baru Generasi F6 Hasil dari 7 Kombinasi Persilangan. *Bul. Agrohorti*, *1*(4), 1–8. https://hsgm.saglik.gov.tr/depo/birimler/saglikli-beslenme-hareketli-hayat-db/Yayinlar/kitaplar/diger-kitaplar/TBSA-Beslenme-Yayini.pdf
Ruchjaniningsih, N., & Thamrin, M. (2016). Penampilan Genotipe Jagung Berumur Genjah pada Pemupukan N Dosis Tinggi dan Rendah di Lahan Sawah setelah Padi di Sulawesi Selatan. *Buletin Plasma Nutfah*, *19*(2), 81. https://doi.org/10.21082/blpn.v19n2.2013.p81-88
Suete, F., Samudin, S., & Hasanah, U. (2017). Growth Response Upland Rice (*Oryza sativa*) Cultivars Local on Various Levels Moisture Land. *e-j. Agrotekbis*, *5*(2), 173–182.
Supriyanti, A., Supriyanta, S., & Kristamtini, K. (2015). Karakterisasi Dua Puluh Padi (*Oryza Sativa* L.) Lokal di Daerah Istimewa Yogyakarta. *Vegetalika*, *4*(3), 29–41.
Syafi'ie, M. M., & Damanhuri. (2018). Uji Daya Hasil Pendahuluan Mutan (M7) Padi Merah (*Oryza Nivara* L.) pada Musim Penghujan. *Jurnal Produksi Tanaman*, *6*(6), 1028–1033.
Syukri, A., Nelvia, N., & Adiwirman, A. (2019). Aplikasi Kompos Tandan Kosong Kelapa Sawit dan Pupuk NPKmg Terhadap Sifat Kimia Tanah Ultisol dan Kadar Hara Daun Kelapa Sawit (*Elaeis guineensis* Jacq). *Jurnal Solum*, *16*(2), 49–59. https://doi.org/10.25077/jsolum.16.2.49-59.2019
Tirtana, A., Purwoko, B. S., Dewi, I. S., & Trikoesoemaningtyas. (2021). Selection of Upland Rice Lines in Advanced Yield Trials and Response to Abiotic Stress. *Biodiversitas*, *22*(10), 4694–4703. https://doi.org/10.13057/biodiv/d221063
Weng, X., Wang, L., Wang, J., Hu, Y., Du, H., Xu, C., Xing, Y., Li, X., Xiao, J., & Zhang, Q. (2014). Grain Number, Plant Height, and Heading Date7 is a Central Regulator of Growth, Development, and Stress Response. *Plant Physiology*, *164*(2), 735–747. https://doi.org/10.1104/pp.113.231308
Yurnawati, Y., Aryana, I. G. ., & Sutresna, I. W. (2018). Uji Daya Hasil Galur Generasi F3 Padi Beras Merah (*Oryza sativa* L.). *Jurnal Sains Teknologi & Lingkungan*, *4*(1), 73–82.

https://doi.org/10.29303/jstl.v4i1.74

Table 1. Results LSI Test of 17 Rice Genotypes of Preliminary Yield Test Results in Generation F_6.

Genotypes	Plant height (cm)	Flag leaf length (cm)	Productive tiller number (tiller)	Flowering age (DAP)	Panicle length (cm)	Harvest age (DAP)	Yield per plot (kg)	Total grain (seeds)	Weight of 1000 seeds (gr)
19I-06-30-17-11(fxd)	86.25 acefg	30.39 b	11.75	79.7 bf	20.52 b	111.00 bf	3.82 f	878.00	25.32 abdef
23A-56-13-25-13(axb)	73.10 acdefg	22.32	18.10 abcfg	63.4 abcdefgh	15.51	100.50 abcefh	3.48	1118.35 bf	25.39 abdef
19I-06-09-23-03(fxd)	82.15 acdefg	32.04 bdh	15.90 acf	71.0 abcdefgh	19.30 b	104.00 bfh	4.93 bf	1732.05 bcdf	25.50 abdef
21B-57-21-21-23(dxa)	96.60 acefg	29.69 b	13.30 c	77.9 abcfh	20.16 b	110.00 bf	5.55 bdf	1104.50 bf	26.38 abdef
23F-04-10-18-18(axd)	88.20 acefg	26.28	16.30 acf	73.6 abcdefgh	18.79 b	114.00 bf	5.59 bdf	873.50	27.66 abdef
21B-57-21-21-25(dxa)	86.80 acefg	25.49	12.25 c	73.3 abcdefgh	20.59 b	110.50 bf	2.84	1045.80 bf	24.11 abdef
23A-56-30-25-12(axb)	88.85 acefg	26.80	13.65 c	75.5 abdefh	19.92 b	110.00 bf	4.15 bf	1082.90 bf	26.03 abdef
23A-56-20-07-20(axb)	92.30 acefg	27.33	35.50 abcdefgh	71.8 abcdefgh	19.00 b	102.50 abfh	6.26 bdf	2923.75 abcdefgh	23.28 bdef
23A-56-24-22-13(axb)	75.70 acdefg	19.56	17.80 abcf	75.8 abdefh	15.57	103.50 bfh	5.11 bf	1073.10 bf	24.77 abdef
23A-56-22-20-05(axb)	76.30 acdefg	24.39	47.70 abcdefgh	80.7 bf	16.48	112.50 bf	9.53 bcdfh	2546.15 abcdefgh	20.73 bf
Balok+LSI (a)	141.21	46.28	15.45	78.6	25.80	103.15	9.91	1885.28	24.10
Banyuasin+LSI (b)	56.76	29.23	17.30	84.5	16.80	115.15	3.83	932.38	20.23
Danau Gaung+LSI (c)	114.86	42.41	11.90	75.2	27.43	101.15	6.90	1274.58	29.76
Inpago 8+LSI (d)	82.56	30.48	20.15	77.1	22.39	98.65	5.51	1421.73	22.44
Inpago 12+LSI (e)	103.66	37.77	18.55	77.8	23.57	102.15	13.23	2417.53	23.13
PBM UBB-1+LSI (f)	151.41	40.64	14.60	86.9	23.61	122.15	3.63	968.83	18.79
Rindang 1+LSI (g)	103.56	37.21	18.00	74.6	25.83	97.65	11.53	2116.83	28.48
$\bar{x}g$+LSI (h)	**72.49**	**30.66**	**26.33**	**78.1**	**20.61**	**104.50**	**8.06**	**1918.39**	**27.89**
LSI	**12.14**	**4.23**	**6.10**	**3.9**	**2.03**	**3.35**	**2.93**	**480.58**	**2.98**

Description: 1. $\bar{x}g$ = Average offspring genotype lines.

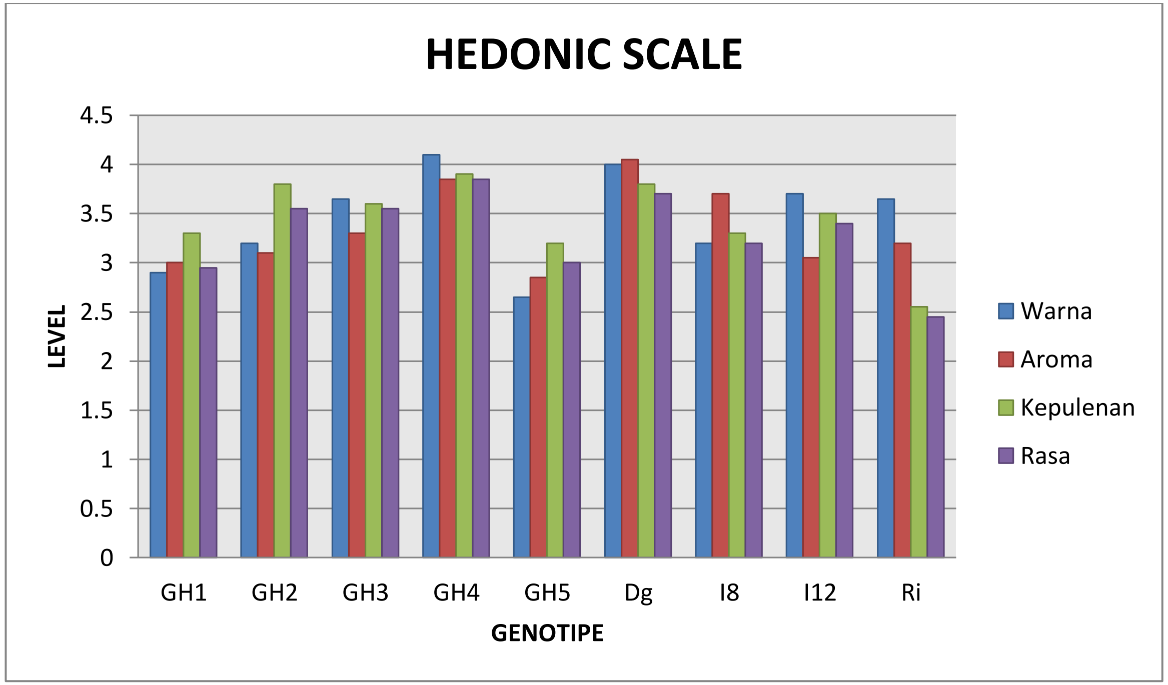
2. The letter behind the number indicates that the test line is better than (a) Balok, (b) Banyuasin, (c) Danau Gaung, (d) Inpago 8, (e) Inpago 12, (f) Rindang 1, and (g) the average genotype of the lineage.
3. The letters in brackets that follow the test line code are the parent of the cross.
4. The test line was better than the comparison on the characters of flag leaf length, number of productive tillers, panicle length, production per plot, total grain count, and 1000 grain weight if the test line check value + LSI, while on the character of plant height, harvest age, and loss if the test line check value – LSI (α = 5%).

Table 2. Results LSI Test of 9 Rice Genotypes of Preliminary Yield Test Results in Generation F_6 and F7 (Second seasons).

Genotypes	Plant height (cm)	Flag leaf length (cm)	Productive tiller number (tiller)	Panicle length (cm)	Harvest age (DAP)	Total grain (seeds)	Yield per plot (kg)	Weight of 1000 seeds (gr)
GH1 (19I-06-09-23-03)	79.12 abcde	31.83 b	23.63 ac	19.89	114.1	1338.47	4.31	28.85
GH2 (21B-57-21-21-23)	93.74 acd	26.91	17.50	20.48	111.25	1012.29	4.05	34.39
GH3 (23A-56-20-07-20)	95.95 acd	24.61	31.38 abcde	21.13	107.5 abe	1942.46 ab	5.22	29.41
GH4 (23A-56-22-20-05)	71.32 abcde	22.39	42.00 abcde	18.10	113.05	1737.88 b	7.20	23.51
GH5 (23F-04-10-18-18)	83.67 abcde	25.85	21.73 a	20.55	114	808.71	4.69	27.53
Dg (DANAU GAUNG) + LSI (a)	113.44	43.40	19.90	30.48	109.92	1895.07	14.02	84.51
I8 (INPAGO 8) + LSI (b)	88.27	30.88	23.78	25.57	107.95	1659.52	8.01	63.83
I12 (INPAGO 12) + LSI (c)	98.62	36.56	23.55	25.85	105.17	2550.90	13.23	83.83
Ri (Rindang) + LSI (d)	103.67	38.46	25.15	27.68	105.67	2111.04	16.59	63.08
RATA2 GENOTIPE (+/-) LSI (e)	**83.83**	**34.02**	**29.93**	**24.88**	**107.72**	**1963.11**	**10.63**	**57.77**
NILAI LSI	**14.66**	**5.06**	**8.15**	**2.83**	**3.83**	**522.34**	**3.67**	**16.20**

Description:

1. $\bar{x}g$ = Average offspring genotype 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 1, and (e) the average genotype of the lineage.
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 flag leaf length, number of productive tillers, panicle length, production per plot, total grain count, and 1000 grain weight if the test line check value + LSI, while on the character of plant height, harvest age, and loss if the test line check value – LSI (α = 5%).



Histogram 1. Panelist's Level of Preference for Color, Aroma, Fluffiness and Taste of Rice

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Potential of Upland Rice Promising Lines in Acid Dry Land at Two Different Seasons

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ABSTRACT

Superior upland rice varieties can be obtained through the plant breeding process. Upland rice lines that are carried out from crossing have different potentials. The research aims to determine upland rice promising lines with high yields in acid-dry land. The study is conducted on Ultisol soil. The first season is in 2019 for F_6 lines, and the second is in 2021 for F_7 lines. The experimental methods use factorial Randomized Block Design (RBD). The treatment at the preliminary yield test use 5 lines 4 varieties, and 1 landrace. The advanced yield test uses 5 F_7 lines (selected from F_6 lines) and 5 types. Analysis data use ANOVA and LSI test. The result shows that lines GH8 and GH10 have the highest yields on acid-dry soils during two planting seasons. The GH_{10} line has a 7.20-9.53 kg/plot yield, and the GH_8 line has a 5.22-6.26 kg/plot. The highest yield potential was the GH_{10} line of 3.69-4.77 t/ha, more increased than Balok, Banyuasin, Danau Gaung, Inpago 8, and PBM-UBB1 varieties. GH_{10} and GH_8 lines are recommended as candidates for new superior varieties of upland rice that are adaptive to acid-dry soils.

INTRODUCTION

Rice (*Oryza sativa* L.) is a primary food crop in Indonesia. The color of rice is caused by the content of anthocyanin pigment (Rathna Priya, Eliazer Nelson, Ravichandran, & Antony, 2019). Total anthocyanin content is higher than white rice (Agustin, Safitri, & Fatchiyah, 2021). Anthocyanins are phenolic compounds that function as antioxidants (Maulani, Sumardi, & Pancoro, 2019). Brown rice has different phenolic content (Gujral, Sharma, Kumar, & Singh, 2012)dried, and milled into grit. The grit from controlled (un-germinated, and white rice has different nutritions (Handajani, Sulandari, Purwidiani, & Zamroh, 2020). The public prefers red rice because it has higher nutrition, but it needs to be developed.

The capacity of food production requires agricultural land that is proportional to the Indonesian population (Rasyid & Kusumawaty, 2022). The main problem of agricultural land in Indonesia is caused by land conversion (Rochadi, Sadiyatunnimah & Salim, 2022). The arable land is getting narrower because used for industry, houses, and others (Munir, S., Afiyah, & Munir, A., 2023). Agricultural transformation is currently being pursued in sub-optimal land areas to increase agricultural production (Riswani, Yunita, & Thirtawati, 2022). Indonesian farmers have recently started to cultivate ultisol-type soil. Ultisol soil is impoverished in nutrients (Suryani, Idris, Nurmansyah, & Nasir, 2022). Soil types in the Bangka Belitung Archipelago Province are classified as Ultisol. Rice production in this province has not met the needs of its population, so it is necessary to increase rice production.

Ultisol-tolerant upland rice varieties can increase rice production in acid soil types. Ultisol soil contains 82.16% clay, pH 5.19, Org-C 18.8 g/kg, and Al-exch 1.92 me/100 g (Yulnafatmawita & Adrinal, 2014). It is essential to develop rice plants that are adaptive to acid-dry land. Due to drought stress, genotypes that cannot adapt to dry acid soil will inhibit vegetative growth and yield production (Tirtana, Purwoko, Dewi, & Trikoesoemaningtyas, 2021). One rice variety that adapts to acid-dry land is Inpago 8 (Nazirah, Purba, Hanum, & Rauf, 2016). The genotypes that adapted to Ultisol Bangka were PBM UBB 1, Danau Gaung and 21B-57-21-21-23 (Mustikarini, Prayoga, Santi, & Wardani,

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2022). PBM UBB1 is a brown rice variety. Danau Gaung dan 21B-57-21-21-23 is white rice.

A superior genotype can be obtained through the hybridization process. Hybridization of landrace Bangka rice with national varieties has been done to get lodging resistance lines. In further research, GH_3 and GH_4 from the F_6 lines can be used as candidates for new superior varieties (Mustikarini, Prayoga, Santi, & Hairul, 2021). Rice plant lines that have been produced need to be tested on acid soils. The results of this study are expected to obtain lines that can adapt to Bangka ultisols. It is hoped that the test results for the two growing seasons will yield data on the average yield of the expected lines on ultisols. The research aims to determine upland rice promising lines that have high yields in acid-dry land.

MATERIALS AND METHODS

The research was conducted in two experimental seasons in December 2020 - April 2021, on ultisol land in Universitas Bangka Belitung, Indonesia.

The research method used was the experimental procedure. The research design applied a randomized block design for each season. The treatment in the first season (preliminary yield test) used 10 upland rice lines (GH_1-GH_{10}) (Table 1). The treatment in the second season used 5 lines GH_3, GH4, GH_5, GH_8, and GH_{10} and 5 check varieties (Table 2). Lines GH_4 was the only remaining line of red rice, while the other lines were white rice. In 1 plot (experimental unit), there are 320 plants. The area of 1 plot is 20 m^2.

F_7 generation of rice plants was observed flag leaf length, plant height, number of productive tillers, panicle length, harvest age, number of unfilled grains, 1000 seed weight, yield per plot, and organoleptic tests. Data analysis used Fisher's test (α 5%) and the Least Significant Increase (LSI) test (formula 1).

$$LSI = t_{(0,05;\,db)} \sqrt{\frac{2MSE}{r}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1)$$

Where: MSE = Mean Square Error; r = replication; $t_{(0,05;db)}$ = t table; α = 5%.

RESULTS AND DISCUSSION

A yield test was carried out identification of lines tolerant to dry acid soils. Plants that tolerate dry, acid soils show high growth and yield. Identification was carried out during two planting seasons. According to Putriani, Yusnaini, Septiana, & Dermiyati (2022), ultisol soil contains 9.14 ppm available-P, 0.98% Organic-C, and 10.78 cmol/kg CEC criteria very low. Ultisol soil has a pH of 3-4, Cation Exchange Capacity (CEC) low and Al-dd high (Muktamar, Lifia, & Adiprasetyo, 2020). Phototoxic aluminum (Al^{3+}) rapidly inhibits root growth, reducing water absorption and nutrients (Rahman et al., 2018). Plants with Al poisoning stunted growth and are abnormal (Herlina & Andarini, 2022).

According to Michel et al. (2017), a preliminary yield test is carried out to determine the potential of superior lines. The initial yield test (season one) showed differences in character between the lines and the comparison varieties. All the lines at this stage had shorter plant heights than all the comparison varieties, except for the Banyuasin variety. The GH_2 line had the shortest plant height of 73.10 cm (Table 1). Rice can be easily identified through phenotype characteristics such as plant height (Rahmawati, Santika, & Fitriyah, 2021; Widyayanti, Hidayatun, Kurniawan, Kristamtini, & Sudarmaji, 2020). The character of plant height < 105 cm is classified as a short plant. The F_6-F_7 generation lines are identified as having short plant height. The character of short plant height was inherited from the two parents of the cross, namely Banyuasin and Inpago 8. According to Huang et al. (2018), plants with short heights allocate more photosynthate to seeds. According to Rahmawati, Santika, & Fitriyah (2021), reducing plant height is the main target to produce lodging resistance in rice.

Two lines had longer flag leaf lengths than the Banyuasin variety, namely GH_1 and GH_3 (Table 1). The number of productive tillers in rice plants affects the number of panicles produced. Early harvest age is thought to result from Inpago 8 and Balok offspring. Mustikarini, Prayoga, Santi, & Hairul (2021) stated that the Hd gene controlled flowering and harvesting age. Weng et al. (2014) indicated that the flowering time gene Ghd7 regulates plant architecture, and genetic and environmental factors influence this regulation. Endo-Higashi & Izawa (2011) stated two essential flowering time genes in rice plants, *Hd1,* and *Ehd1*, also control panicle development. Early harvest age is the desired harvest age in the plant breeding process.

Table 1. Results of LSI test of 17 rice genotypes of preliminary yield test results in generation F_6.

Genotypes	Plant height (cm)	Flag leaf length (cm)	Productive tiller number (tiller)	Flowering age (DAP)	Panicle length (cm)	Harvest age (DAP)	Yield per plot (kg)	Total grain (seeds)	Weight of 1000 seeds (g)
GH_1 (fxd)	86.25 acefg	30.39 b	11.75	79.7 bf	20.52 b	111.00 bf	3.82 f	878.00	25.32 abdef
GH_2 (axb)	73.10 acdefg	22.32	18.10 abcfg	63.4 abcdefgh	15.51	100.50 abcefh	3.48	1118.35 bf	25.39 abdef
GH_3 (fxd)	82.15 acdefg	32.04 bdh	15.90 acf	71.0 abcdefgh	19.30 b	104.00 bfh	4.93 bf	1732.05 bcdf	25.50 abdef
GH_4 (dxa)	96.60 acefg	29.69 b	13.30 c	77.9 abcfh	20.16 b	110.00 bf	5.55 bdf	1104.50 bf	26.38 abdef
GH_5 (axd)	88.20 acefg	26.28	16.30 acf	73.6 abcdefgh	18.79 b	114.00 bf	5.59 bdf	873.50	27.66 abdef
GH_6 (dxa)	86.80 acefg	25.49	12.25 c	73.3 abcdefgh	20.59 b	110.50 bf	2.84	1045.80 bf	24.11 abdef
GH_7 (axb)	88.85 acefg	26.80	13.65 c	75.5 abdefh	19.92 b	110.00 bf	4.15 bf	1082.90 bf	26.03 abdef
GH_8 (axb)	92.30 acefg	27.33	35.50 abcdefgh	71.8 abcdefgh	19.00 b	102.50 abfh	6.26 bdf	2923.75 abcdefgh	23.28 bdef
GH_9 (axb)	75.70 acdefg	19.56	17.80 abcf	75.8 abdefh	15.57	103.50 bfh	5.11 bf	1073.10 bf	24.77 abdef
GH_{10} (axb)	76.30 acdefg	24.39	47.70 abcdefgh	80.7 bf	16.48	112.50 bf	9.53 bcdfh	2546.15 abcdefgh	20.73 bf
Balok + LSI (a)	141.21	46.28	15.45	78.6	25.80	103.15	9.91	1885.28	24.10
Banyuasin + LSI (b)	56.76	29.23	17.30	84.5	16.80	115.15	3.83	932.38	20.23
Danau Gaung +LSI (c)	114.86	42.41	11.90	75.2	27.43	101.15	6.90	1274.58	29.76
Inpago 8 + LSI (d)	82.56	30.48	20.15	77.1	22.39	98.65	5.51	1421.73	22.44
Inpago 12 + LSI (e)	103.66	37.77	18.55	77.8	23.57	102.15	13.23	2417.53	23.13
PBM UBB-1 + LSI (f)	151.41	40.64	14.60	86.9	23.61	122.15	3.63	968.83	18.79
Rindang 1 + LSI (g)	103.56	37.21	18.00	74.6	25.83	97.65	11.53	2116.83	28.48
$\bar{x}g$+LSI (h)	**72.49**	**30.66**	**26.33**	**78.1**	**20.61**	**104.50**	**8.06**	**1918.39**	**27.89**
LSI	**12.14**	**4.23**	**6.10**	**3.9**	**2.03**	**3.35**	**2.93**	**480.58**	**2.98**

Remarks: $\bar{x}g$ = Average offspring genotype lines; The letter behind the number indicates that the test line is better than (a) Balok, (b) Banyuasin, (c) Danau Gaung, (d) Inpago 8, (e) Inpago 12, (f) Rindang 1, and (g) the average genotype of the lineage; The letters in brackets that follow the test line code are the parent of the cross; The test line was better than the comparison on the characters of flag leaf length, number of productive tillers, panicle length, production per plot, total grain count, and 1000 grain weight if the test line check value + LSI, while on the character of plant height, harvest age, and loss if the test line check value – LSI (α = 5%).

Table 2. Results of LSI test of 9 rice genotypes of preliminary yield test results in generation F_6 and F_7 (second seasons).

Genotypes	Plant height (cm)	Flag leaf length (cm)	Productive tiller number (tiller)	Panicle length (cm)	Harvest age (DAP)	Total grain (seeds)	Yield per plot (kg)	Weight of 1000 seeds (g)
GH_3	79.12 abcde	31.83 b	23.63 ac	19.89	114.1	1338.47	4.31	28.85
GH_4	93.74 acd	26.91	17.50	20.48	111.25	1012.29	4.05	34.39
GH_5	95.95 acd	24.61	31.38 abcde	21.13	107.5 abe	1942.46 ab	5.22	29.41
GH_8	71.32 abcde	22.39	42.00 abcde	18.10	113.05	1737.88 b	7.20	23.51
GH_{10}	83.67 abcde	25.85	21.73 a	20.55	114	808.71	4.69	27.53
Danau Gaung + LSI (a)	113.44	43.40	19.90	30.48	109.92	1895.07	14.02	84.51
Inpago 8 + LSI (b)	88.27	30.88	23.78	25.57	107.95	1659.52	8.01	63.83
Inpago 12 + LSI (c)	98.62	36.56	23.55	25.85	105.17	2550.90	13.23	83.83
Rindang + LSI (d)	103.67	38.46	25.15	27.68	105.67	2111.04	16.59	63.08
$\bar{x}g$+LSI (e)	**83.83**	**34.02**	**29.93**	**24.88**	**107.72**	**1963.11**	**10.63**	**57.77**
LSI	**14.66**	**5.06**	**8.15**	**2.83**	**3.83**	**522.34**	**3.67**	**16.20**

Remarks: $\bar{x}g$ = Average offspring genotype lines; The letter behind the number indicates that the test line is better than (a) Danau Gaung, (b) Inpago 12, (c) Inpago 8, (d) Rindang 1, and (e) the average genotype of the lineage; The letters in brackets that follow the test line code are the parent of the cross; The test line was better than the comparison on the characters of flag leaf length, number of productive tillers, panicle length, production per plot, total grain count, and 1000 grain weight if the test line check value + LSI, while on the character of plant height, harvest age, and loss if the test line check value – LSI (α = 5%).

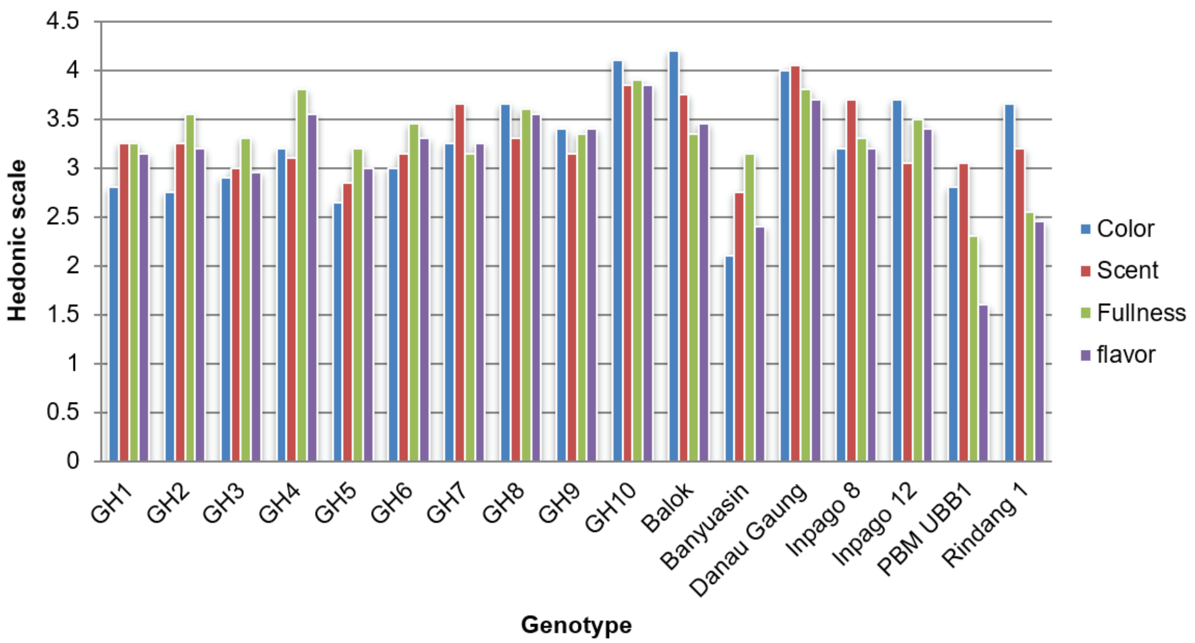

Fig. 1. Panelist's Level of Preference for Color, Aroma, Fluffiness and Taste of Rice

The test line with the longest panicle of 20.6 cm was GH_6, while the shortest, 15.5 cm, was GH_2 (Tabel 1). The longer the panicle, the more grain will be produced. Lines with better characteristics than the comparison varieties can be used as superior lines. The GH_4 line has a plant height of 71.32 cm. This line (GH_4) is classified as having a short plant height (Table 2). All rice plant lines tested had lower plant heights than the check variety. The GH2 line has the highest plant height of 93.74 cm.

Early harvest age is the desired harvest age in the plant breeding process. The speedy age of rice harvest also does not necessarily increase productivity. The character of the total grain amount is known based on the total number of grains in one plant clump, including empty grain. The total grain number of test lines ranged from 873.5-2923.75, with the highest total grain number of GH_8 (Table 1). A high amount of grain will also be followed by a high crop production. The weight of 1000 seeds of the lines tested showed a higher value than the parents, namely 23.3-27.7 g. The line with the lowest 1000 seed weight was GH_{10}, with an average weight of 20.7 g. The magnitude of the importance of 1000 seeds is not necessarily accompanied by high production.

Mardiah, Septianingrum, Handoko, & Kusbiantoro (2017) stated that the colors consumers like are bright, while consumers do not like dull colors. The rice color of line GH_{10} is preferred because it is red compared to other lines (Fig. 1). A pair of genes belonging to each test line is a combination of two parental alleles. The dominant allele will be expressed, while the recessive allele that is not expressed will still be inherited in the gametes formed in the offspring. Following the dominant trait, one of the parents will produce a white epidermis, while the recessive trait will produce less red epidermis. The Rc gene sequence controls the red color in rice. The OSB1 gene sequence controls black rice, while white rice is controlled by the *DFR* gene (Lim & Ha, 2013).

The GH_{10} line produced grain weighing 9.53 kg/plot, and the GH_8 line produced 6.26 kg/plot grain. The GH_{10} is the line that has the highest yield. The high yield of the GH_{10} lines was supported by the character of yield per plot, productive tillers number, plant height, and harvest age. Mustikarini, Prayoga, Santi, & Hairul (2021) added Long panicles have a more significant burden so that rice stalks become curved and prone to fall. It makes long panicles not necessarily able to increase production. The GH_{10} lines have the highest yield in two growing seasons. The second highest yield was GH_8 lines. The GH_{10} line is classified as brown rice.

CONCLUSION AND SUGGESTION

Lines GH_8 and GH_{10} had the highest acid-dry soil yield during two planting seasons. The GH_{10} line had a 7.20-9.53 kg/plot yield, and the GH8 line had a 5.22-6.26 kg/plot. The highest yield potential was the GH_{10} line of 3.69-4.77 t/ha, more increased than Balok, Banyuasin, Danau Gaung, Inpago 8, and PBM-UBB1 varieties. GH_{10} and GH_8 lines are recommended as candidates for superior varieties of upland rice that are adaptive to acid-dry soils.

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REFERENCES

Agustin, A. T., Safitri, A., & Fatchiyah. (2021). Java red rice (*Oryza sativa* L.) nutritional value and anthocyanin profiles and its potential role as antioxidant and anti-diabetic. *Indonesian Journal of Chemistry*, *21*(4), 968–978. https://doi.org/10.22146/ijc.64509

Endo-Higashi, N., & Izawa, T. (2011). Flowering time genes *heading date 1* and *early heading date 1* together control panicle development in rice. *Plant and Cell Physiology*, *52*(6), 1083–1094. https://doi.org/10.1093/pcp/pcr059

Gujral, H. S., Sharma, P., Kumar, A., & Singh, B. (2012). Total phenolic content and antioxidant activity of extruded brown rice. *International Journal of Food Properties*, *15*(2), 301–311. https://doi.org/10.1080/10942912.2010.483617

Handajani, S., Sulandari, L., Purwidiani, N., & Zamroh, B. S. (2020). Study of rice analog from cassava–soybean and processed product. Paper presented at *Proceedings of the 2nd International Conference on Social, Applied Science, and Technology in Home Economics (ICONHOMECS 2019)* (pp. 287–297). Atlantis Press. https://doi.org/10.2991/assehr.k.200218.046

Herlina, L., & Andarini, Y. N. (2022). Screening and evaluation of 100 upland rice accessions for developing high-yielding upland rice varieties tolerant against acid soil. *AIP Conference Proceedings, 2462*, 020019. https://doi.

org/10.1063/5.0075550

Huang, J., Li, J., Zhou, J., Wang, L., Yang, S., Hurst, L. D., … Tian, D. (2018). Identifying a large number of high-yield genes in rice by pedigree analysis, whole-genome sequencing, and CRISPR-Cas9 gene knockout. *Proceedings of the National Academy of Sciences of the United States of America*, *115*(32), E7559–E7567. https://doi.org/10.1073/pnas.1806110115

Lim, S.-H., & Ha, S.-H. (2013). Marker development for the identification of rice seed color. *Plant Biotechnology Reports*, *7*(3), 391–398. https://doi.org/10.1007/s11816-013-0276-1

Mardiah, Z., Septianingrum, E., Handoko, D. D., & Kusbiantoro, B. (2017). Improvement of red rice eating quality through one-time polishing process and evaluation on its phenolic and anthocyanin content. *International Journal of Agriculture, Forestry and Plantation*, *5*, 22–28. Retrieved from https://ijafp.org/wp-content/uploads/2017/10/AG-9.pdf

Maulani, R. R., Sumardi, D., & Pancoro, A. (2019). Total flavonoids and anthocyanins content of pigmented rice. *Drug Invention Today*, *12*(2), 369–373. Retrieved from https://bit.ly/3Yz3Z8D

Michel, S., Ametz, C., Gungor, H., Akgöl, B., Epure, D., Grausgruber, H., … Buerstmayr, H. (2017). Genomic assisted selection for enhancing line breeding: merging genomic and phenotypic selection in winter wheat breeding programs with preliminary yield trials. *Theoretical and Applied Genetics*, *130*(2), 363–376. https://doi.org/10.1007/s00122-016-2818-8

Muktamar, Z., Lifia, & Adiprasetyo, T. (2020). Phosphorus availability as affected by the application of organic amendments in ultisols. *Sains Tanah - Jurnal of Soil Science and Agroclimatology*, *17*(1), 16–22. https://doi.org/10.20961/stjssa.v17i1.41284

Munir, S., Afiyah, S., & Munir, A. (2023). Forms of legal protection due to the conversion of agricultural land into residential and industrial land. *Equalegum – International Law Journal*, *1*(1), 14–31. Retrieved from https://syntificpublisher.com/index.php/equalegum/article/view/2

Mustikarini, E. D., Prayoga, G. I., Santi, R., & Hairul, H. (2021). Genetic parameters of F6 upland rice with lodging resistance derived from landraces x national varieties. *IOP Conference Series: Earth and Environmental Science*, *741*, 012010. https://doi.org/10.1088/1755-1315/741/1/012010

Mustikarini, E. D., Prayoga, G. I., Santi, R., & Wardani, K. (2022). Adaptation test for upland rice genotypes in Balunijuk village rice fields with ultisol type. *IOP Conference Series: Earth and Environmental Science*, *1108*, 012026. https://doi.org/10.1088/1755-1315/1108/1/012026

Nazirah, L., Purba, E., Hanum, C., & Rauf, A. (2016). Characterization of tolerant upland rice to drought on rooting and physiology system. *Journal of Agriculture and Life Sciences*, *3*(2), 43–49. Retrieved from https://jalsnet.com/journals/Vol_3_No_2_December_2016/5.pdf

Putriani, S. S., Yusnaini, S., Septiana, L. M., & Dermiyati. (2022). *Aplikasi biochar dan pupuk P terhadap ketersediaan dan serapan P pada tanaman jagung manis (Zea mays* Saccharata Sturt.*) di tanah ultisol*. *Jurnal Agrotek Tropika, 10*(4), 615–626. https://doi.org/10.23960/jat.v10i4.6447

Rahman, Md. A., Lee, S.-H., Ji, H. C., Kabir, A. H., Jones, C. S., & Lee, K.-W. (2018). Importance of mineral nutrition for mitigating aluminum toxicity in plants on acidic soils: Current status and opportunities. *International Journal of Molecular Sciences*, *19*(10), 3073. https://doi.org/10.3390/ijms19103073

Rahmawati, D., Santika, P., & Fitriyah, A. (2021). Characterization of several rice (*Oryza sativa* L.) varieties as germplasm. *Food and Agricultural Sciences: Polije Proceedings Series, 3*(1), 1–6. Retrieved from https://proceedings.polije.ac.id/index.php/food-science/article/view/140

Rasyid, T. H., & Kusumawaty, Y. (2022). Omnibus law and the challenges of the Indonesian agricultural sector: An islamic perspective. *Islamic Research*, *5*(1), 49–61. https://doi.org/10.47076/jkpis.v5i1.119

Rathna Priya, T. S., Eliazer Nelson, A. R. L., Ravichandran, K., & Antony, U. (2019). Nutritional and functional properties of coloured rice varieties of South India: A review. *Journal of Ethnic Foods*, *6*(1), 11. https://doi.org/10.1186/s42779-019-0017-3

Riswani, Yunita, & Thirtawati. (2022). Prospects and feasibility of implementation of agricultural transformation for food crops on sub optimal land in Ogan Ilir Regency, South Sumatra. *IOP Conference Series: Earth and Environmental Science*, *995*, 012016. https://doi.org/10.1088/1755-1315/995/1/012016

Rochadi, A. S., Sadiyatunnimah, S., & Salim, K. (2022). Agricultural land conversion and human trafficking in Northern Java Island, Indonesia. *Asian Journal of Agriculture and Rural Development*, *12*(3), 173–181. https://doi.org/10.55493/5005.v12i3.4563

Suryani, E., Idris, H., Nurmansyah, & Nasir, N. (2022). Effect of harvest interval on the productivity of three varieties of citronela grass planted on ultisol soil. *IOP Conference Series: Earth and Environmental Science*, *1097*, 012007. https://doi.org/10.1088/1755-1315/1097/1/012007

Tirtana, A., Purwoko, B. S., Dewi, I. S., & Trikoesoemaningtyas. (2021). Selection of upland rice lines in advanced yield trials and response to abiotic stress. *Biodiversitas Journal of Biological Diversity*, *22*(10), 4694–4703. https://doi.org/10.13057/biodiv/d221063

Weng, X., Wang, L., Wang, J., Hu, Y., Du, H., Xu, C., … Zhang, Q. (2014). *Grain number, plant height, and heading date7* is a central regulator of growth, development, and stress response. *Plant Physiology*, *164*(2), 735–747. https://doi.org/10.1104/pp.113.231308

Widyayanti, S., Hidayatun, N., Kurniawan, H., Kristamtini, & Sudarmaji. (2020). Local rice genetic resource management in AIAT Yogyakarta: For supporting industrial revolution 4.0. *AIP Conference Proceedings*, *2260*, 050001. https://doi.org/10.1063/5.0016403

Yulnafatmawita, & Adrinal. (2014). Physical characteristics of ultisols and the impact on soil loss during soybean (*Glycine max* Merr) cultivation in wet tropical area. *AGRIVITA Journal of Agricultural Science*, *36*(1), 57–64. https://doi.org/10.17503/agrivita-2014-36-1-p057-064