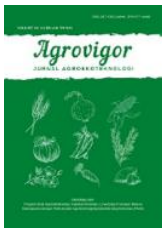
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Article

Morphological Characteristics, Seed Quality, and Seedling Growth of Several Local Rice (*Oryza sativa* L.) Genotypes

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ABSTRACT

Rice (*Oryza sativa* L.) is a major staple crop, and the declining existence of local rice varieties highlights the need for their identification and evaluation as valuable genetic resources for future rice improvement. This study aimed to analyze differences in seed morphology, seed quality, and seedling growth of three local rice genotypes compared with Situbagendit variety. A Completely Randomized Design (CRD) with one factor was used, involving three local rice genotypes (Sedayu, HMS 700, and Tri Sultan 05) and one comparison variety (Situbagendit). The study was conducted in three stages: seed morphological characterization, seed quality testing, and field evaluation at the vegetative phase. Observed seed traits included grain length, grain width, grain color, lemma and palea pubescence, awn color, and pericarp color. Seed quality parameters included seed moisture content, seed purity, 1,000 seed weight, germination percentage, vigor index, maximum growth potential, and germination rate, and germination uniformity. Field observations included leaf color, plant height, fresh and dry weight. Data were analyzed using ANOVA at the 5% level, followed by Duncan's Multiple Range Test (DMRT). This study showed that several rice genotypes exhibited differences in seed morphological characteristics, included pericarp color and grain length. The seed quality of the Tri Sultan 05 genotype was higher than comparison variety in 1,000 seed weight, and had similar quality in terms of germination percentage, maximum growth potential, vigor index, and germination rate. Tri Sultan 05 also showed better early seedling growth, particularly in plant height and fresh weight.

INTRODUCTION

Rice (*Oryza sativa* L.) is one of the most important commodities in global agriculture and plays a crucial role in ensuring food security in many countries, particularly in Asia. Rice provides more than 50% of the caloric and protein requirements for over 3 billion people worldwide. In Indonesia, rice is the primary staple food and plays an important role in food security (Rozi et al., 2023). According to Rachmat (2022), the majority of farmers in Indonesia cultivate improved rice varieties such as Ciherang (44.48%), IR-64 (12.92%), and local varieties (7.65%). These data indicate that local rice seeds have gradually become marginalized and are increasingly threatened with extinction if conservation efforts are not implemented. Prior to the introduction of high-quality rice seeds, Indonesian farmers cultivated more than 8,000 local rice varieties.

Local rice varieties are recognized for their broad adaptability to diverse agroecosystems, ranging from upland to lowland areas. In Indonesia, these varieties are cultivated across several major islands, including Java, Kalimantan, Sulawesi, and Papua, with Java having the largest cultivation area, followed by Kalimantan and Sulawesi. Various local rice genotypes cultivated by farmers include upland rice types such as Sedayu, HMS 700, and Tri Sultan 05, as well as regional varieties such as Gropak, Dharma Ayu, Srimulih, Andel Jaran, Merong, Gundelan, Marong, Simenep, and Ketan Lusi. However, advances in agricultural technology and the increasing adoption of improved rice varieties have gradually reduced the use of local rice among farmers. Consequently, several traditional varieties are now cultivated only in limited areas. This situation highlights the importance of conservation efforts to preserve local rice germplasm as valuable genetic resources and to maintain rice biodiversity in Indonesia (Toha, 2019).

Morphologically, local rice varieties generally exhibit tall plant stature, longer and thicker stems, wider leaves, and strong root systems. Nevertheless, local rice varieties may exhibit several limitations, such as longer growth duration, taller plant stature associated with lodging susceptibility, and, in certain conditions, lower yield potential than improved varieties. Despite these constraints, local rice varieties possess valuable traits that can be utilized in future rice breeding programs. For example, they often show strong adaptability to suboptimal environments, desirable grain quality, fragrant aroma, and resistance to certain pests (Iskandar and Iskandar, 2018).

One approach to conserving local rice germplasm is through exploration in regions where these varieties are still cultivated, followed by proper documentation and registration. The existence of numerous rice types reflects the presence of genetic diversity within rice plants. Such diversity can be identified through morphological characterization. Through the observation of morphological traits, similarities and differences among rice varieties can be directly identified, providing an effective approach to understanding plant diversity.

Morphological characterization enables the identification of superior traits and supports the selection of promising rice varieties. Morphological characterization is particularly important because it provides information on the strengths and weaknesses of each variety and reveals genetic relationships among rice varieties, which can serve as a foundation for rice breeding programs. One important aspect of characterization involves the observation of seed characteristics, including seed size, shape, and color. Seed characterization aims to identify and determine the physical quality characteristics of rice seeds in detail. In addition, seed quality evaluation is conducted to determine the overall performance and quality of seeds. Seed quality generally consists of genetic quality, physiological quality, and physical quality. Genetic quality is determined by the degree of genetic purity, while physiological quality is influenced by the rate of seed deterioration and seed vigor. Meanwhile, physical quality is determined by the level of physical cleanliness of the seeds (A'yun et al., 2023). Information regarding seed morphological characteristics and seed quality of in various local rice genotypes is essential as a basis for plant breeding programs. Evaluating these characteristics can provide valuable information regarding the genetic potential possessed by each local rice genotype.

The Situbagendit genotype is an improved rice variety developed by the Indonesian Agency for Agricultural Research and Development (Balittan) and is the result of a cross between the Batur variety and the line S2823-7D-8-1-A. Meanwhile, Sedayu, HMS 700 (Haji Muhammad Soeharto), and Tri Sultan 05 are local rice genotypes originating from Kebumen. However, information regarding seed morphological characteristics, seed quality, and seedling growth of

several local rice genotypes such as Sedayu, HMS 700, and Tri Sultan 05 remains limited. Therefore, this study aims to evaluate the seed morphological characteristics, seed quality, and seedling growth of several local rice genotypes as basic information for determining parental lines in rice breeding programs.

MATERIALS AND METHODS

This study was conducted from January to March 2025 at the Plant Breeding and Seed Technology Laboratory, and Greenhouse of the Faculty of Agriculture, Universitas Pembangunan Nasional Veteran Yogyakarta. The main materials used in this study were three local rice genotypes (Sedayu, HMS 700, and Tri Sultan 05) and one comparison variety Situbagendit. The genotypes used in this study were denoted as follows: G1 = Situbagendit, G2 = Sedayu, G3 = HMS 700, G4 = Tri Sultan 05. Other materials included distilled water (distilled water), plastic, opaque paper, soil, manure, and water. The equipment used in this study included an oven, analytical balance, seed containers, aluminum cups, seed purity table, basin, tweezers, germinator, rubber bands, microscope, petri dishes, Munsell Color Chart, stationery, ruler, labels, documentation tools, buckets, and watering cans. The seeds come from an agricultural store with the same harvest period in October 2024.

The study was conducted in three experimental stages. Stage I, was the characterization of seed morphology conducted using a Completely Randomized Design (CRD) in the laboratory with one factor consisting of four rice genotype treatments. Each treatment was repeated six times, resulting in 24 experimental units. In each experimental unit, 20 rice seeds were used as observation samples. Thus, the total number of seeds used in the seed morphology characterization stage was 480 seeds. The observed seed morphological characteristics included grain length, grain width, grain color, lemma and palea pubescence, awn color, and pericarp color.

Stage II, was the seed quality testing conducted in the laboratory using a Completely Randomized Design (CRD) with one factor consisting of four treatments and six replications, resulting in 24 experimental units. In each experimental unit, 50 seeds were used for germination testing. Therefore, the total number of seeds used in the laboratory seed quality testing stage was 1,200 seeds. The measurement of grain length and grain width was conducted using ImageJ software. Observations of morphological characteristics referred to the Characterization and Evaluation System Guidelines published by the Department of Agriculture, Agency for Agricultural Research and Development, while grain color was determined using the Munsell Color Chart. The observed seed quality parameters included seed moisture content, seed purity, 1,000 seed weight, germination percentage, vigor index, maximum growth potential, and germination rate, and germination uniformity. Germination percentage testing was conducted using the rolled paper method in a germinator. Each replicate consisted of 50 seeds placed on moistened paper media using distilled water. The germination test was carried out under controlled laboratory conditions at a temperature of 25 ± 2°C for 14 days. The first count was performed on the 5th day after sowing, while the final count was conducted on the 14th day. Normal seedlings were evaluated according to ISTA seed testing standards. Germination percentage was calculated based on the proportion of normal seedlings at the final count. The vigor index was determined based on the percentage of normal seedlings at the first count, while germination rate was calculated using the germination rate formula. Seed moisture content was calculated based on direct methode. The seeds are oven dried at constant temperature of 130^{o}C for 2 hours.

Stage III was a field experiment conducted to observe the vegetative growth of rice plants. This experiment also used a Completely Randomized Design (CRD) in greenhouse with one factor consisting of four treatments and six replications, resulting in 24 experimental units. In each experimental unit, five buckets were used as planting media, and two rice seeds were planted in each bucket. Thus, the total number of seeds used in the field experiment was 240 seeds. The sample plants used for growth observation consisted of three plants in each experimental unit. Field test parameters observed included leaf color, plant height, fresh weight, and dry weight.

The data obtained from the study were analyzed using Analysis of Variance (ANOVA) at a 5% significance level. If the results showed significant differences among treatments, the analysis was followed by Duncan's Multiple Range Test (DMRT) at a 5% significance level to determine differences among treatments.

RESULTS AND DISCUSSION

Seed Morphological Characterization

Qualitative Parameters

The qualitative parameters observed included grain color, lemma and palea pubescence, awn color, and pericarp color. These data were obtained based on the dominant characteristics observed in each replication and referred to the Guidelines for the Characterization and Evaluation System of Rice Plants issued by the Department of Agriculture, Agency for Agricultural Research and Development.

Based on table 1, differences in grain color were observed among the genotypes. The Situbagendit, HMS 700, and Tri Sultan 05 genotypes showed straw-yellow grain color, while the Sedayu genotype showed straw-yellow grain color with brown spots, which may indicate the presence of seed discoloration or possible fungal contamination. Similar symptoms have been reported in rice grains affected by brown spot disease caused by fungal pathogens (Jannah et al., 2023).

Table 1 also shows that lemma and palea pubescence consisted of short hairs, and there were no differences among the genotypes. Furthermore, table 1 indicates that the color of the awn color was golden yellow in all genotypes, showing no variation among them. Differences were found in pericarp color, where the Situbagendit and Tri Sultan 05 genotypes produced white pericarp, while Sedayu and HMS 700 produced yellowish pericarp. These data refer to the Guidelines for the Characterization and Evaluation System of Rice Plants issued by the Department of Agriculture, Agency for Agricultural Research and Development (Moeljopawiro et al., 2023).

Quantitative Parameters

The parameters for this quantitative character are grain length and grain width. Based on table 2, the grain length parameter showed that the Tri Sultan 05 genotype had a grain length that was not significantly different from the comparison genotype Situbagendit, but it was significantly longer than that of the Sedayu and HMS 700 genotypes. According to Angga and Frilynthia (2020), grain length is classified into three categories: short (<7.5 mm), medium (7.5–12 mm), and long (>12 mm). The results in table 2 show that Situbagendit and Tri Sultan 05 were categorized as long grains, while Sedayu and HMS 700 were categorized as medium grains. Grain length characterization can be used to distinguish different rice varieties (A'yun et al., 2023). Grain length may contribute to grain quality characteristics and could be associated with agronomic performance.

Table 2 also shows that there were no significant differences among genotypes in the grain width parameter. According to Angga and Frilynthia (2020), grain width is classified into three categories: narrow (<1 mm), medium (1–3 mm), and wide (>3 mm). The results in Table 2 indicate that the grain width of each genotype falls into the medium category. Grain width is one of the indicators that determine grain shape and is measured based on the distance between the widest sides of the grain.

According to Santana et al. (2021), grain length and grain width are influenced by both genetic and environmental factors. The observed diversity is caused by genetic differences such as variations in morphology (physical form) and distant genetic relationships. In addition to genetic factors, the growing environment also contributes to variations in these characteristics.

Table 1. Qualitative morphological characteristics of three local rice genotypes compared with Situbagendit variety

Genotype	GC	LPB	AC	PC
Situbagendit (G1)	Straw Yellow	Short	Golden Yellow	White
Sedayu (G2)	Straw Yellow	Short	Golden Yellow	Yellowish
HMS 700 (G3)	Straw Yellow	Short	Golden Yellow	Yellowish
Tri Sultan 05 (G4)	Straw Yellow	Short	Golden Yellow	White

Note: Grain Color (GC), Lemma and Palea Pubescence (LPB), Awn Color (AC), and Pericarp Color (PC)

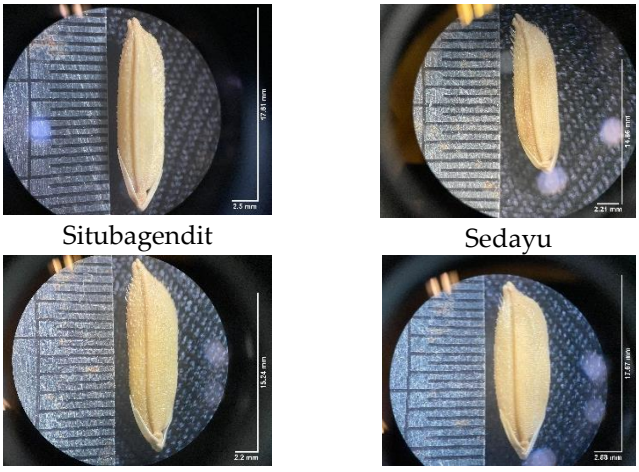


Figure 1. of three local rice genotypes compared with Situbagendit variety

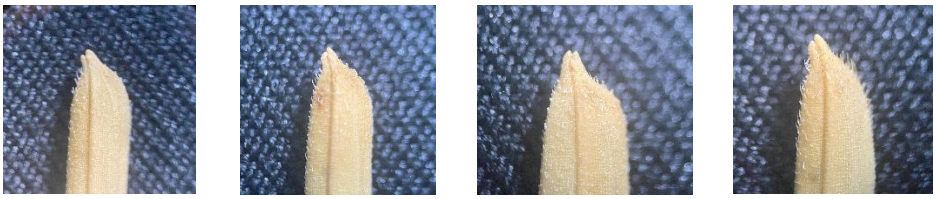


Figure 2. Lemma and Palea Pubescence and Awn Color of three local rice genotypes compared with Situbagendit variety

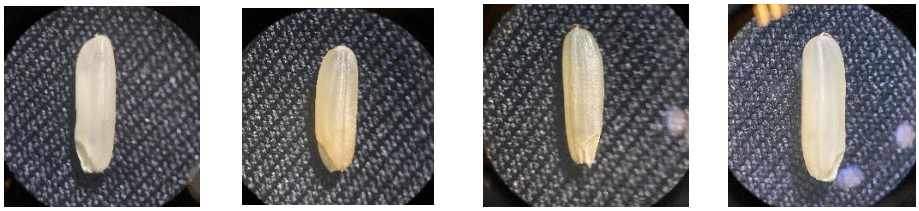


Figure 3. Pericarp Color of three local rice genotypes compared with Situbagendit variety

Table 2. Quantitative morphological characteristics of rice genotypes

Genotype	Grain Length (mm)	Grain Width (mm)
Situbagendit (G1)	13.34 a	2.65 a
Sedayu (G2)	10.35 c	2.00 a
HMS 700 (G3)	11.97 b	2.15 a
Tri Sultan 05 (G4)	12.99 a	2.81 a
Rerata	12.16	2.40

Note: Mean values followed by the same letter in the same column indicate no significant difference based on DMRT at the 5% significance level.

Seed Quality Test

Seed Moisture Content

There were no significant differences among genotypes in seed moisture content 1,000 seed weight parameter, that presented in table 2. Seed moisture content did not differ significantly among genotypes. Seed moisture content is an important parameter because it affects seed viability, storage life, and overall seed quality. Appropriate moisture content helps maintain seed germination ability during storage and ensures

compliance with seed quality standards. According to the Regulation of the Minister of Agriculture No. 355 of 2019, the maximum moisture content for rice seeds during storage is around 13%. The results shown in Table 3 indicate that the moisture content values of each genotype are in accordance with the seed quality standards.

Table 2. Mean seed moisture content (%) and 1,000 seed weight (g) of three local rice genotypes compared with Situbagendit variety

Genotype	Moisture Content (%)	1,000 Seed Weight (g)
Situbagendit (G1)	12.2 a	25.50 b
Sedayu (G2)	11.4 a	20.89 d
HMS 700 (G3)	11.7 a	22.82 c
Tri Sultan 05 (G4)	12.7 a	27.12 a
Mean	12	24.08

Note: Mean values followed by the same letter in the same column indicate no significant difference based on DMRT at the 5% significance level.

1,000 Seed Weight

Based on table 2, the Tri Sultan 05 genotype had a significantly higher 1,000 seed weight compared to the other genotypes, while the lowest value was observed in the Sedayu genotype. The 1,000 seed weight indicates the quality of seeds based on their weight. Differences in the 1,000 seed weight among genotypes are influenced by both genetic and environmental factors. Genetic differences cause variations in seed size, seed shape, and seed density, which ultimately affect the 1,000 seed weight. Environmental factors such as nutrient availability, water, temperature, and pest attacks may also influence the 1,000 seed weight (Kurniawan and Azmi, 2021).

According to Alfarabi et al. (2024), seed diameter is closely related to the 1,000 seed weight, where medium and small seeds generally have lower weight. Larger seed size indicates a higher 1,000 seed weight and greater food reserves compared to smaller seeds. As shown in table 2, the lower 1,000 seed weight observed in the Sedayu genotype may be related to its smaller seed size. Smaller seeds may contain fewer food reserves, which can result in lower 1,000 seed weight values.

Seed Purity

These results indicate that the purity parameter has no significant effect between genotypes. The average purity is presented in table 3. There were no significant differences among genotypes in terms of pure seeds and innert matter. The results of this purity test showed that no seeds from other plant species were found; only inert matter were observed, indicating that the tested seeds met the required standards. According to Karuntu (2021), the certification standard for rice seeds in the certified seed class requires a minimum of 99.0% pure seeds and a maximum of 1.0% inert matter. Higher seed purity reflects better physical seed quality and suitability for seed certification standards. This test is one of the indicators used to determine the physical quality of seeds because it is related to seed size and fullness. The results in table 3 show that the purity values of each genotype meet the certification standards.

Table 3. Mean pure seed and inert matter of three local rice genotypes compared with Situbagendit variety

Genotype	Pure Seed (%)	Inert Matter (%)
Situbagendit (G1)	99.75 a	0.22 a
Sedayu (G2)	99.66 a	0.32 a
HMS 700 (G3)	99.66 a	0.27 a
Tri Sultan 05 (G4)	99.71 a	0.28 a
Mean	99.70	0.28

Note: Mean values followed by the same letter in the same column indicate no significant difference based on DMRT at the 5% significance level.

The seed inert matter observed during the test included empty grains, panicle stalks, and broken seeds with size equal to or less than half of the normal seed size. According to Aruan et al., (2019), innert matter include seeds and all other materials or structures that are not part of the seed. Inert matter consisting of seed parts include peeled seed coats, broken or damaged seeds with size less than half of their original size, empty grains, and husks. Other impurities that are not part of the seed structure include soil, sand, stones, straw, panicle stalks, and other materials.

Germination Percentage

Genotype treatment significantly affected germination percentage, maximum growth potential. These results indicate that genotype significantly affected germination percentage. Based on table 4, the germination percentage showed that the HMS 700 and Tri Sultan 05 genotypes had germination percentages that were not significantly different from the comparison genotype Situbagendit, but were significantly higher than the Sedayu genotype. HMS 700 Anda Tri Sultan 05 can be categorized as high-quality seeds because their germination percentage exceeded 80%, and Sedayu just had a minimum percentage. The higher the germination percentage, the better the seed quality.

Seed germination provides information to seed users about the ability of seeds to grow normally and develop into productive plants under optimal environmental conditions. Seeds are considered normal if the seedlings possess all essential seedling structures that develop properly (Suparto et al., 2022). The observation of the number of normal seedlings is one of the criteria used to determine seed quality. Germination begins with the emergence of the plumule and radicle from the seed embryo. The plumule and radicle serve as indicators of normal seedlings when the growing environment is supportive (Megasari et al., 2024).

Table 4. Mean germination percentage and maximum seed growth potential (%) of three local rice genotypes compared with Situbagendit variety

Genotype	Germination percentage (%)	Maximum Growth Potential (%)
Situbagendit (G1)	94.00 a	97.00 a
Sedayu (G2)	80.00 b	83.67 b
HMS 700 (G3)	91.67 a	96.33 a
Tri Sultan 05 (G4)	95.67 a	97.67 a
Mean	90.33	93.67

Note: Mean values followed by the same letter in the same column indicate no significant difference based on DMRT at the 5% significance level.

Maximum Growth Potential

Based on Table 4, the parameter of maximum growth potential showed that the HMS 700 and Tri Sultan 05 genotypes had values that were not significantly different from the comparison genotype Situbagendit, but were significantly higher than the Sedayu genotype. Maximum growth potential indicates the ability of seeds to grow and develop either normally or abnormally within certain limits. According to Fresela et al. (2025), good maximum growth potential in seeds is above 80%.

Seeds that are sown will continue to grow over time, and the extent to which seeds grow reflects their growth potential. The ability of plants to grow and develop properly depends on the condition of the seeds. According to Wahyuni and Chrisna (2019), the ability of seeds to maintain their quality varies among individual seeds within a population; therefore, maximum growth potential refers to seeds that are able to grow either normally or abnormally within certain limits.

A high maximum growth potential value indicates that the seeds have good viability and are capable of germinating under ideal conditions (Wahab et al., 2025). Wahyuni and Chrisna (2019) also stated that maximum growth potential has a strong positive correlation with germination percentage. The higher the germination rate, the higher the maximum growth potential. This is consistent with table 7, which shows that the Situbagendit, HMS 700, and Tri Sultan 05 genotypes had high germination percentages and

maximum growth potential. In contrast, the Sedayu genotype showed the lowest maximum growth potential percentage, which is consistent with the germination results that also showed the lowest percentage.

Vigor Index

Genotype treatment significantly affected vigor index, that presented in table 5. Situbagendit and Tri Sultan 05 showed significantly higher vigor index values than Sedayu, while HMS 700 was not significantly different from the other genotypes. Overall, the tested genotypes demonstrated relatively good seed vigor, indicating their ability to germinate and grow under suboptimal environmental conditions.

The vigor test is conducted to determine the ability of seeds to germinate normally under optimal conditions and maintain growth under suboptimal environmental conditions. Vigor testing is indicated by the first count, where the first count calculation serves as an indicator of germination speed, reflecting the quality of seeds in initiating early growth. The higher the first count value, the better the seed vigor, indicating that the seeds are able to germinate more quickly under both standard and stress conditions. The first count represents the number of seeds that successfully germinate at the early stage of testing, which assesses how quickly seeds begin to grow (Azmi et al., 2022).

The results in table 5 show that the Situbagendit and Tri Sultan 05 genotypes had relatively high vigor index values of 81.33% and 82.33%, respectively, while the Sedayu genotype showed the lowest value. The high vigor index values observed in the Situbagendit and Tri Sultan 05 genotypes indicate better seed vigor and a greater ability to germinate under various environmental conditions. Seeds with low vigor show a reduced ability to grow normally under unfavorable environmental conditions such as extreme temperature or humidity (Saputra et al., 2024). Each variety has different seed coat thickness, resulting in different responses. Factors that influence the decline in seed vigor include genetic factors, growing environment, and storage conditions (Fatonah and Rozen, 2017).

Table 5. Mean vigor index of three local rice genotypes compared with Situbagendit variety

Treatment (Genotype)	Vigor index (%)	Germination rate (%normal seedlings day^{-1})	Germination uniformity (%)
Situbagendit (G1)	81.33 a	25.47 a	95.67 a
Sedayu (G2)	72.00 b	18.26 b	75.33 c
HMS 700 (G3)	77.33 ab	19.91 b	86.67 b
Tri Sultan 05 (G4)	82.33 a	26.37 a	94.33 a
Mean	78.25	22.50	88

Note: Mean values followed by the same letter in the same column indicate no significant difference based on DMRT at the 5% significance level.

Germination Rate

The germination rate was measured by adding up the number of sprouts every day per plant during the germination period. Genotype treatment significantly affected germination rate, that presented in table 5. The germination rate parameter showed that the Tri Sultan 05 genotype was not significantly different from the comparison genotype Situbagendit, but was significantly higher than the Sedayu and HMS 700 genotypes.

Germination rate indicates seed vigor because seeds that germinate faster are more capable of adapting to suboptimal field conditions. Seeds with a high germination rate generally have higher vigor (Hayati et al., 2021). According to Fatikhasari et al. (2022), seeds with a germination rate ranging from 25–30% are categorized as having high vigor. The results in Table 9 show that the germination rate values of Situbagendit and Tri Sultan 05 fall within this high-vigor category.

Germination Uniformity

Genotype treatment significantly affected germination uniformity. Observations were made on the number of normal sprouts between the first and second counts. For rice seeds, observations of growth synchrony were conducted on the 10th day. The germination uniformity is presented in table 5 below.

The germination uniformity of the Tri Sultan 05 genotype was not significantly different from the comparison genotype Situbagendit, but it was significantly higher than that of the Sedayu and HMS 700 genotypes. These results indicate that the seeds have high germination uniformity. Germination uniformity reflects the ability of seeds to utilize their energy reserves effectively during the germination process.

According to Fatikhasari et al. (2022), germination uniformity values generally range between 40–70%, where values above 70% indicate very high seed vigor, while values below 40% indicate low vigor. The results in table 5 show that the germination uniformity values of all genotypes exceeded 70%. Germination uniformity is one of several indicate that strong seed vigor and uniform seedling growth. High germination uniformity suggests that the seed population grows synchronously and possesses strong growth potential (Akib et al., 2019).

Field Experiments

Leaf Color

Leaf color observations were conducted using a Munsell color chart as a visual indicator of leaf greenness. Rice leaf color is presented in table 6. Based on table 8, the observation of leaf color using the Munsell Color Chart showed a value of 5GY 5/8, which represents 5GY (green–yellow) with a value of 5 (moderate brightness between dark and light) and a chroma of 8 (relatively bright). This indicates that the rice plants had a soft yellowish-green leaf color, and no differences in leaf greenness were observed among the genotypes. According to Nugroho (2019), the standard leaf color for optimal rice growth ranges from 5GY 5/8 to 5GY 6/8.

Table 6. Observation results of leaf color three local rice genotypes compared with Situbagendit variety

Genotype	Leaf Color Scale
Situbagendit (G1)	5GY 5/8
Sedayu (G2)	5GY 5/8
HMS 700 (G3)	5GY 5/8
Tri Sultan 05 (G4)	5GY 5/8

Note: 5GY 5/8 (soft yellowish green).

The results in Table 6 indicate that the observed values fall within this range, suggesting that the rice plants had sufficient nitrogen content without excess, allowing optimal growth. The absence of differences in leaf color among genotypes suggests that nitrogen uptake and chlorophyll formation during the vegetative stage were relatively similar under the experimental conditions.

Plant Height

In the life cycle of plants, there are two important phases, one of which is the vegetative growth phase. Vegetative growth itself is a process that includes germination, as well as the growth of roots, stems, and leaves. This growth is characterized by an increase in the volume, number, shape, and size of vegetative organs (leaves, stems, and roots). During the vegetative growth stage, plants increase in height and produce more leaves (Rumbay et al., 2021). At 28 days after planting (DAP), rice plants enter the vegetative phase, which is also referred to as the early growth stage. In this phase, plants focus on vegetative growth such as the development of roots, stems, and leaves (Muhtar and Purwandhi, 2019).

Based on Table 7, the Tri Sultan 05 genotype showed the greatest increase in plant height. At 7 DAP, the plant height of Tri Sultan 05 was significantly higher than that of HMS 700, but was not significantly different from Situbagendit and Sedayu. At 21 DAP, Tri Sultan 05 was not significantly different from Situbagendit, but showed significantly greater plant height than Sedayu and HMS 700. At 28 DAP, Tri Sultan 05 showed significantly greater plant height compared to all other genotypes.

Table 7 also shows that the Sedayu genotype had the lowest increase in plant height, which is consistent with its germination percentage and vigor index results that showed the lowest values. The lower plant height observed in the Sedayu genotype may also be associated with lower seed vigor and possible seed health problems, including fungal infection observed on the grains. This occurs because each genotype has

different genetic characteristics and different adaptability to environmental conditions. In addition, seed size can also influence growth, as smaller seeds may not have sufficient energy reserves to germinate properly (Nazirah and Damanik, 2019).

Table 7. Mean plant height at 7, 14, 21, and 28 of three local rice genotypes compared with Situbagendit variety

Genotype	Days After Planting (cm)			
	7 DAP	14 DAP	21 DAP	28 DAP
Situbagendit (G1)	16.67 ab	19.31 a	25.72 ab	34.06 b
Sedayu (G2)	13.39 ab	18.50 a	23.75 b	30.92 b
HMS 700 (G3)	15.25 b	18.83 a	25.00 b	32.34 b
Tri Sultan 05 (G4)	17.03 a	20.17 a	27.42 a	37.14 a
Mean	15.59	19.20	25.47	33.61

Note: Mean values followed by the same letter in the same column indicate no significant difference based on DMRT at the 5% significance level.

Plant height is a characteristic inherent to an individual plant. Differences in rice plant height can be caused by genetic differences among individuals. As stated by Afdila et al. (2021), the genetic composition of an individual is one of the factors that influences the visible appearance of that individual. In addition to genetic factors, plant morphology is also influenced by environmental factors. Seeds derived from different genotypes will produce variation in plant appearance because each individual has distinct characteristics that reflect its diversity, making it possible to observe differences among individuals. Differences in plant height can also be attributed to the genetic factors of each genotype. This is consistent with the opinion of Nazirah and Damanik (2019), who stated that differences in genetic composition are one of the factors causing variation in plant appearance, including plant height. Plant height in rice can be used as one of the growth parameters; however, taller plant growth does not necessarily guarantee higher yield.

Fresh Weight and Dry Weight

Genotype treatment significantly affected fresh weight and dry weights, that presented in table 8. Based on Table 8, at 28 days after planting (DAP), Tri Sultan 05 exhibited the highest fresh and dry weight among the genotypes. Fresh weight of Tri Sultan 05 was significantly higher than Situbagendit, Sedayu, and HMS 700. For dry weight, Tri Sultan 05 was significantly higher than Sedayu, while Situbagendit and HMS 700 were not significantly different from the other genotypes.

Table 8. Fresh weight and dry weight of three local rice genotypes compared with Situbagendit variety

Genotype	Fresh Weight (g)	Dry Weight (g)
Situbagendit (G1)	1.36 b	0.28 ab
Sedayu (G2)	1.12 b	0.20 b
HMS 700 (G3)	1.33 b	0.27 ab
Tri Sultan 05 (G4)	1.81 a	0.31 a
Mean	1.40	0.27

Note: Mean values followed by the same letter in the same column indicate no significant difference based on DMRT at the 5% significance level.

Fresh weight is the total weight of a plant measured immediately after harvest to prevent rapid water loss through evaporation, as fresh weight reflects the water content and moisture of the plant (Tri and Nopiyanto, 2020). Plant fresh weight is also influenced by the amount of water absorbed; the greater the amount of water absorbed, the higher the fresh weight of the plant.

The higher fresh and dry weights observed in Tri Sultan 05 indicate better biomass accumulation during early vegetative growth. This performance may be associated with its larger seed size, higher germination

percentage, and better seed vigor compared to the other genotypes. Plant dry weight reflects the accumulation of photosynthates and the efficiency of nutrient uptake during growth. According to Dewi et al. (2021), plant biomass is closely related to nutrient absorption capacity, where reduced nutrient uptake leads to lower biomass production. Therefore, dry weight can be used as an indicator of plant growth performance.

Differences in fresh and dry weight among genotypes may be associated with genetic variation, particularly seed size. The smaller seed size of the Sedayu genotype (G2) may have limited the availability of stored nutrients, which in turn could affect early seedling development, including root and leaf growth, and ultimately reduce both fresh and dry weight. In addition, fungal infection observed on the seeds may have contributed to reduced seedling growth and biomass accumulation in this genotype. This is supported by Warbaal et al. (2019), who reported that seed size influences the amount of stored starch and nutrients, which affect germination and early seedling development.

Fresh and dry weights are closely related, where a decrease in fresh weight is generally followed by a decrease in dry weight due to reduced biomass accumulation (Afdila et al., 2021). Overall, dry weight reflects photosynthetic efficiency; therefore, higher photosynthetic activity results in greater biomass accumulation and potentially higher yield (Tri and Nopiyanto, 2020).

CONCLUSION

This study showed that several rice genotypes exhibited differences in seed morphological characteristics, included pericarp color and grain length. The seed quality of the Tri Sultan 05 genotype was higher than comparison variety in 1,000 seed weight, and had similar quality in terms of germination percentage, maximum growth potential, vigor index, and germination rate. Tri Sultan 05 also showed better early seedling growth, particularly in plant height and fresh weight. However, further evaluation under field conditions and seed health testing are needed before this genotype can be recommended as a potential parental line in rice breeding programs.

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