



Growth, Components, and Yield Capacity of 14 Rice (*Oryza Sativa* L.) Genotypes by Anther Culture

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Abstract

Background. Anther culture techniques have great potential for increasing productivity, quality, and competitiveness of crop commodities through anther culture techniques to obtain pure double haploid lines.

Aims. Through breeding activities, it is hoped that a variety of new superior lines can be produced, which in addition to having high productivity, also possess several other characteristics that support efforts to improve quality and competitiveness.

Methods. The experiment was conducted in Lengkong Village, Bojongsoang District, Bandung Regency. The daily temperature range during the experiment was between 16°C and 29°C, and the relative humidity ranged from 60% to 95%. Rainfall during the study varied between 48.26 mm - 256.54 mm. Temperature, relative humidity, and rainfall at the experimental location were in the optimal range for rice cultivation. The genetic material used was 14 rice genotypes consisting of 12 dihaploid (DH) lines from IPB anther culture and 2 comparison varieties, namely Bioni 63 Agritan Ciherang and Inpari 18. The lines tested were FS3-15-2-2, FS3-29-1-2, FS3-36-3-1, FS3-47-1-1, FS3-60-1-2, FS3-67-2-1, FS4-13-2-1, FS4-27-2-1, FS4-27-3-1, FS4-34-1-1, FS4-41-1-2, FS442-2-2.

Conclusion The test results showed: 1) There were differences in growth characteristics, yield components, and yield capacity of 14 rice genotypes (12 anther cultures and 2 control varieties. 2) The twelve tested lines had the same yield capacity as the Bioni63 Ciherang Agritan variety and were superior to the Inpari 18 variety.

Keywords: Growth, Yield Components, Yield Capacity, Rice Lines, Anther Culture



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INTRODUCTION

Another culture technique is often used to obtain homozygous doubled haploid lines in a short time (Carsono et al., 2022; Lantos et al., 2022; Dewi et al., 2024). Anther culture is a strategy to reduce selection time, thereby shortening the breeding cycle, producing pure homozygous lines in just one generation (Akbar et al., 2019; Syafii et al., 2018; Safitri et al., 2016; Azmi et al., 2017). Linton et al. (2020) noted that selection methods are an efficient way

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to obtain highly important traits and demonstrate a high success rate. If a trait has sufficiently high genetic diversity, then the variation of that trait among individuals in the population will be significant, facilitating the selection of desired traits.

Rice variety development can be accelerated by using anther culture techniques. Anther culture can produce perfectly homozygous lines in just 1-2 generations, while conventional breeding typically requires 5-6 or even 8-10 generations (Carsono et al., 2022; Iriani et al., 2025; Feng et al., 2026). Developing new superior varieties through anther culture techniques is expected to advance rice breeding in Indonesia (Sciences, 2022). Prasetia et al. (2022) and Firdaus et al. (2022) suggest that using dihaploid plants from anther culture for breeding can increase selection efficiency, minimize costs, time, and labor, as pure lines with high homozygosity can be produced directly in the first generation. Furthermore, this technology can reliably secure dominant genes for inheritance to subsequent generations, enabling the creation of several stable transgressive segregating lines. The anther culture method has long been used in rice breeding to accelerate variety improvement by simplifying the selection process. Through anther culture, pure lines can be generated and selected from a uniform, homozygous, doubled haploid population.

Plant lines resulting from plant breeding programs need to be tested and evaluated for improved properties relative to the reference varieties used. The tendency of farmers to continuously plant the same varieties can lead to the emergence of new biotype pests, it is important to find alternative varieties for rotation use. According to Linton et al. (2020), plant breeding activities generally include the following stages: (1) germplasm collection; (2) characterization; (3) selection; (4) evaluation and research; and (5) variety release and propagation. It is hoped that breeding efforts will produce several new superior lines that not only demonstrate high productivity but also exhibit other characteristics that support efforts to improve quality and competitiveness.

This study aims to investigate the rice lines resulting from anther culture that have superior properties by analyzing the growth, yield components, and yield power of 14 rice lines (*Oryza sativa* L.) resulting from anther culture, including 2 comparison varieties, namely Bioni 63, Agritan Ciherang, and Inpari 18, so that there are 16 rice genotypes.

Genotype is a genetic composition that is relatively constant, even though it is influenced by the environment. Genotypes can be lines or varieties. Lines are offspring from crosses that have certain growth and usually have not reached stability and have not been named. Lines consist of pure lines and promising lines. The definition of pure lines is offspring

that have the same characteristics as their parents, which come from self-pollination even after several times, while promising lines are offspring from crosses that have certain growth and are usually not stable, have not been named, and the lines in question are superior lines, which will be sought as the best lines as hopes for getting varieties (Ulum, 2018).

Dihaploid (DH) plants have a homozygous genetic makeup, thus providing advantages in increasing diversity, especially recessive traits, and accelerating the development of superior varieties (Anshori et al., 2018). Developing new superior varieties through anther culture techniques is expected to support the success of rice breeding in Indonesia (Sciences, 2022). Genotypes obtained from breeding programs such as anther culture must be characterized to identify dihaploid lines with potential for development in rice breeding.

This study offers a novel contribution by evaluating the agronomic performance and yield capacity of 12 doubled haploid rice lines derived from anther culture under field conditions, using Bioni 63 Agritan Ciherang and Inpari 18 as comparison varieties. Unlike previous studies that mainly emphasize the efficiency of anther culture in producing homozygous lines, this research demonstrates the practical yield potential of selected anther-culture-derived genotypes, indicating their suitability as promising candidates for rice variety development.

MATERIALS AND METHODS

This experiment was conducted in the BPSBTPH rice fields on Jl. Ciganitri II, Bojongsoang, Bandung Regency, at an elevation of approximately 680 meters above sea level. The soil classification is Ultisol.

The materials used were 12 rice lines developed through anther culture at IPB (FS3-15-2-2, FS3-29-1-2, FS3-36-3-1, FS3-47-1-1, FS3-60-1-2, FS3-67-2-1, FS4-13-2-1, FS4-27-2-1, FS4-27-3-1, FS4-34-1-1, FS4-41-1-2, FS442-2-2) and two control varieties, namely Bioni 63 Agritan Ciherang and Inpari 18.

This study used a Yanmar EF494T tractor, Yanmar RH 170 rotary implement, Tiler 48 chopping knife, hoe, sickle, tape measure, RHS Color Chart, standard system guidelines for rice, and a Mettler Toledo analytical balance. and a Dolle 400 moisture meter.

This study used a simple randomized block design (RBD) with 14 treatments and 3 replications

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RESULTS AND DISCUSSION

Table 1. Plant Height, Number of Productive Tillers, Flowering Time, and Harvest Time of 14 Rice Genotypes

Genotype	Plant Height (cm)		Number of Productive Tillers (fruits)	Flowering Time (DAP)	Harvest Time (DAP)
	Vegetative	Generative			
A = FS3-15-2-2	87,98 ^{ab}	90,03 ^{ab}	32,60 ^{ab}	76,67 ^{ab}	118,33 ^a
B = FS3-29-1-2	96,51 ^c	94,37 ^{ab}	28,47 ^a	74,67 ^{ab}	116,67 ^a
C = FS3-36-3-1	93,00 ^{bc}	97,90 ^b	28,90 ^a	75,33 ^{ab}	117,00 ^a
D = FS3-47-1-1	87,13 ^{ab}	94,42 ^{ab}	32,13 ^{ab}	77,67 ^b	118,00 ^a
E = FS3-60-1-2	86,55 ^{ab}	89,32 ^{ab}	32,57 ^{ab}	77,00 ^b	118,33 ^a
F = FS3-67-2-1	87,97 ^{ab}	88,50 ^{ab}	30,07 ^{ab}	73,67 ^{ab}	116,00 ^a
G = FS4-13-2-1	86,17 ^{ab}	97,73 ^b	34,60 ^{ab}	74,33 ^{ab}	116,33 ^a
H = FS4-27-2-1	90,14 ^{abc}	86,98 ^{ab}	28,67 ^a	75,00 ^{ab}	115,67 ^a
I = FS4-27-3-1	87,70 ^{ab}	86,23 ^{ab}	30,57 ^{ab}	73,33 ^{ab}	117,00 ^a
J = FS4-34-1-1	91,88 ^{bc}	92,52 ^{ab}	30,33 ^{ab}	73,67 ^{ab}	116,00 ^a
K = FS4-41-1-2	93,28 ^{bc}	91,97 ^{ab}	32,83 ^{ab}	72,33 ^a	116,33 ^a
L = FS442-2-2	87,64 ^{ab}	84,37 ^{ab}	29,33 ^a	74,33 ^{ab}	117,00 ^a
M = Inpari 18	83,02 ^a	81,40 ^a	38,65 ^b	77,00 ^b	118,33 ^a
N = Bioni63 Ciherang Agritan	89,90 ^{abc}	80,83 ^a	28,45 ^a	76,67 ^{ab}	118,33 ^a

Note: Numbers followed by the same letter in the same column are not significantly different based on the 5% BNJ test.

Each rice genotype has unique traits that allow it to respond differently to its growing environment. Identifying rice germplasm with superior traits is crucial in rice variety breeding, as each genotype exhibits distinct characteristics (Mawaddah et al., 2018). Rice is an important staple food crop worldwide due to its adaptability to various environmental conditions. Rice has significant economic and social importance, and its increasing demand necessitates the development of new varieties with improved agronomic characteristics, such as stress tolerance (Romero & Arias, 2019).

Table 1 shows that the maximum vegetative plant height was recorded in genotype B = FS3-29-1-2, which was significantly different from other genotypes, except for genotypes C = FS3-36-3-1, H = FS4-27-2-1, J = FS4-34-1-1, K = FS4-41-1-2, and genotype N = Bioni63 Ciherang.

The highest generative plant height was recorded in genotype C = FS3-36-3-1, which differed significantly from genotypes M = Inpari 18 and N = Bioni 63 Ciherang, but was not significantly different from the other genotypes.

The highest number of productive tillers was observed in genotype M = Inpari 18, which differed significantly from genotypes B = FS3-29-1-2, C = FS3-36-3-1, H = FS4-27-2-1, L = FS442-2-2, and N = Bioni 63 Ciherang, but did not differ significantly from other varieties. This is consistent with the view of Akbar et al. (2022), who stated that each rice variety has distinct characteristics under various growing conditions.

The fastest flowering time was recorded in genotype K = FS4-41-1-2 compared to genotypes D = FS3-47-1-1, E = FS3-60-1-2, and M = Inpari 18, but did not differ significantly from other treatments.

Harvest time for all tested genotypes did not differ significantly, indicating that each genotype (line or comparison variety) had a relatively similar harvest time.

Table 2. Panicle Length and Number of Empty Grains of 14 Rice Genotypes

Genotype	Panicle Length (cm)	Number of Empty Grains (grains)
A = FS3-15-2-2	22,90 ^a	26,13 ^{abc}
B = FS3-29-1-2	25,17 ^a	22,27 ^{ab}
C = FS3-36-3-1	23,37 ^a	15,60 ^a
D = FS3-47-1-1	23,18 ^a	14,50 ^a
E = FS3-60-1-2	22,37 ^a	19,00 ^a
F = FS3-67-2-1	22,58 ^a	14,57 ^a
G = FS4-13-2-1	23,65 ^a	17,30 ^a
H = FS4-27-2-1	22,53 ^a	18,93 ^a
I = FS4-27-3-1	24,05 ^a	42,00 ^c
J = FS4-34-1-1	22,23 ^a	11,87 ^a
K = FS4-41-1-2	22,60 ^a	15,13 ^a
L = FS442-2-2	25,13 ^a	27,80 ^{abc}
M = Inpari 18	23,15 ^a	38,83 ^{bc}
N = Bioni63 Ciherang Agritan	23,43 ^a	14,60 ^a

Note: Numbers followed by the same letter in the same column are not significantly different based on the 5% BNJ test.

Table 2 shows that panicle length across all tested genotypes was not significantly different. The lowest number of empty grains was obtained in lines C = FS3-36-3-1, D = FS3-47-1-1, E = FS3-60-1-2, F = FS3-67-2-1, G = FS4-13-2-1, H = FS4-27-2-1, J = FS4-34-1-1, K = FS4-41-1-2, and N = Bioni63 Ciherang Agritan. This was significantly different from lines I = FS4-27-3-1 and M = Inpari 18, but not significantly different from the other lines. Line I = FS4-27-3-1 produced the highest empty grain weight compared to other genotypes except genotypes A = FS3-15-2-2, L = FS442-2-2, and M = Inpari 18.

Table 3. Harvested Dry Grain Weight, Milled Dry Grain Weight, and Conversion Yield

Genotype	Grain Weight (kg/plot)		Conversion (tons per hectare)
	Harvested Dry Grain	Milled Dry Grain	
A = FS3-15-2-2	18,40 ^b	16,13 ^b	9,89
B = FS3-29-1-2	18,97 ^b	15,80 ^b	9,72
C = FS3-36-3-1	17,30 ^b	15,16 ^b	9,42
D = FS3-47-1-1	18,93 ^b	16,31 ^b	10,02
E = FS3-60-1-2	17,50 ^b	14,88 ^b	9,77
F = FS3-67-2-1	14,97 ^b	14,84 ^b	8,26
G = FS4-13-2-1	16,67 ^b	14,84 ^b	9,11
H = FS4-27-2-1	15,47 ^b	13,46 ^b	8,50
I = FS4-27-3-1	14,80 ^b	14,98 ^b	8,27
J = FS4-34-1-1	17,83 ^b	15,84 ^b	9,83
K = FS4-41-1-2	16,30 ^b	14,60 ^b	9,29
L = FS442-2-2	17,73 ^b	15,51 ^b	9,96
M = Inpari 18	7,90 ^a	6,62 ^a	4,27
N = Bioni63 Ciherang Agritan	17,30 ^b	14,77 ^b	9,28

Note: Numbers followed by the same letter in the same column are not significantly different based on the 5% BNJ test.

Table 3 shows that all evaluated lines had non-significant differences in harvested dry grain weight and milled dry grain weight compared to the Bioni 63 Ciherang Agritan variety, but were significantly different from the Inpari 18 variety. All tested anther culture lines produced higher harvested dry grain weight and milled dry grain weight compared to the Inpari 18 variety. High yield is the primary goal of rice breeding (Afifah et al., 2020). Assessment of initial harvest yield is part of the selection process for developing new varieties. Selection of yield and its component traits is a complex process, as yield traits are quantitative. Gunarsih et al. (2022) conducted research using selection indices to identify doubled-haploid rice lines with high yield potential and favorable agronomic traits. Appropriate selection methods can increase the efficiency of obtaining superior rice genotype varieties.

Aspect	Academic Formulation
State of the Art	Anther culture is an advanced rice-breeding technique used to accelerate the production of homozygous doubled haploid lines. This method shortens the breeding cycle compared with conventional breeding and supports the development of new superior rice varieties with stable agronomic traits. Previous

Aspect	Academic Formulation
Research Gap	<p>studies have emphasized the value of doubled-haploid rice lines for improving selection efficiency, yield potential, and varietal development.</p> <p>Although another culture has been widely recognized as an efficient breeding method, field evaluation of specific doubled haploid rice lines remains necessary to identify genotypes with superior growth, yield components, and yield capacity under local agroecological conditions. In particular, comparative performance data between anther-culture-derived lines and existing reference varieties are still limited.</p>
Novelty	<p>This study provides a field-based evaluation of 12 doubled-haploid rice lines derived from anther culture and compares them with two reference varieties, Bioni 63, Agritan Ciherang, and Inpari 18. The novelty lies in identifying anther-culture-derived rice lines that show yield capacity comparable to Bioni 63 Agritan Ciherang and superior to Inpari 18, supporting their potential as promising breeding materials for new high-yielding rice varieties.</p>

CONCLUSION

1. There are differences in growth characteristics, components, and yield capacity of 14 rice genotypes (12 anther culture lines and 2 reference varieties).
2. The twelve tested lines have the same yield capacity as the Bioni 63 Ciherang Agritan variety (Harvested Dry Grain and Milled Dry Grain) and are superior to the Inpari 18 variety.

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