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Performance Test of Vegetative Characteristics of Crossed Rice (*Oryza sativa* L.) Lines of Ciherang Variety X B11143D Line in Telagasari, Karawang Regency, Indonesia

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Abstract. One way to increase the genetic diversity of Ciherang as the superior variety is to cross Ciherang with the donor B11143D line as a New Plant Type (NPT) rice. This study aimed to obtain Ciherang X B11143D lines with the best vegetative characteristics in the field. The research was conducted in rice fields in Talagasari Village, Telagasari District, Karawang Regency, from May to September 2023. This experiment used a single-factor Randomized Block Design (RBD) with three replications of 22 treatments, consisting of 19 Ciherang X B11143D lines and three comparison varieties. The effect of treatment was studied using analysis of variance. The results showed that the rice lines significantly influenced the vegetative characters of Ciherang X B11143D lines in Telagasari, Karawang Regency. Based on the observed characters, several lines were selected i.e. 124.2.3, 94.3.3, and 20.4.4 lines. Those three lines chosen as backcrossing lines performed similarly compared to Ciherang as recurrent parent and inherited several important traits for rising productivity from the B11143D line as donor parent, namely the length and area of flag leaf, the total number of tillers, and the number of productive tillers, which were significantly higher than Ciherang.

Keywords: B11143D line; Ciherang variety; field test; rice; vegetative characteristics

INTRODUCTION

Rice is a staple food in Indonesia. The production of rice is 53.98 million tons of Milled Dry Grain (MDG) in 2023. It decreases 767.98 thousand tons or 1.4% compared to rice production of 54,75 million tons MDG in 2022 (BPS, 2023). This is a hard challenge for the Indonesian agricultural sector because the demand for rice will increase along with the increase in population. Also, rice production is assumed to drop by 65 million tons in 2050 if the climate change conditions still exist. It urges the enhancement of rice varieties' production, quality, and diversity (Santhiawan and Suwardhike, 2019).

The superior rice varieties are one of the technological components essential to increase the productivity and production of domestic rice (Prabawa and Purba, 2019; Tajudin et al., 2020). One of the superior varieties that greatly contributes to national rice production is Ciherang. In addition to its high yield potential, the shape of Ciherang rice grains is ideal in clear yellow color with fluffier rice, making this variety always in demand by farmers and consumers. According to Widyaningtias et al. (2020) the production number of tillers in Ciherang variety is 20-25 stems, but not all are productive. The nature of rice resistance is generally unstable with the resilience of a variety can change (Suarsana et al., 2020). To enhance its productivity and resistance to biotic and abiotic stress, Ciherang was crossed with donor New Plant Type (NPT) rice. It is hoped that donor superior traits related to the yield potential enter the Ciherang genome (Susilowati et al., 2014).

Rice backcrossing is a valuable way to enhance the agronomic performance and yield of favourite varieties which used as recurrent parent (Uehara et al. (2017). The effort to introduce new yield potential traits from the B11143D line as donor parental into Ciherang genome was carried out through the backcross method. For an efficient selection in each backcross population, the genetic markers were used to select the desired genotype based on the introgressed donor chromosome segments referred to as CSSL (Chromosome Segment Substitution Lines).

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With several backcrossing, it is expected to increase genetic diversity and yield characters in the progenies population (Susilowati et al., 2014). Therefore, this research aimed to obtain progenies with better vegetative performance than Ciherang in field test in Karawang regency.

METHODS

This research was conducted in rice fields in Talagasari Village, Telagasari Subdistrict, Karawang, West Java from May to September 2023. The materials used were 22 genotypes consisting of 19 progenies from the cross of Ciherang x B11143D line and 3 comparison varieties/lines (Ciherang, B11143D line, and Inpari 32), where each sample consisted of 180 seeds. Urea fertilizer, NPK fertilizer, herbicides, pesticides, and molluscicides were also used. The vegetative characters observed were plant height, flag leaf length, flag leaf area, flowering time, number of tillers, and number of productive tillers.

The research method used is an experimental method using a single-factor Randomized Group Design (RGD), with the further test used is the DMRT (Duncan Multiple Range Test). In this study there were 22 treatments, each with 3 replications. The experimental plot area of each treatment was 2.5 x 1.5 m with a spacing of 25 x 25 cm. The total number of experimental plots was 66 experimental plots. The following treatment codes and descriptions can be seen in **Table 1.** The implementation of this research has several experimental stages, namely land management, nursery and seedling, planting, fertilization, weeding, control of plant-disrupting organisms, and irrigation.

Table 1. Name of progenies from the cross of Ciherang x B11143D line and the comparison varieties tested in Karawang Regency

No.	Name of Line/ Variety	Genomic insertion position of donor parent (B11143D line)	Field Code
1	1.2.4	Chromosome 1	A
2	1.5.1	Chromosome 1	B
3	2.3.3	Chromosome 1	C
4	11.2.1	Chromosome 1	D
5	15.1.3	Chromosome 4	E
6	15.2.2	Chromosome 4	F
7	20.4.4	Chromosome 6	G
8	22.4.3	Chromosome 6	H
9	70.3.2	Chromosome 1	I
10	72.2.3	Chromosome 1	J
11	94.3.3	Chromosome 1	K
12	96.5.4	Chromosome 1	L
13	100.5.1	Chromosome 2	M
14	102.5.5	Chromosome 2	N
15	105.5.1	Chromosome 5	O
16	112.1.3	Chromosome 6	P
17	112.4.5	Chromosome 6	Q
18	115.1.5	Chromosome 7	R
19	124.2.3	Chromosome 11	S
20	Ciherang	Comparison	T
21	B11143D line	Comparison	U
22	Inpari 32	Comparison	V

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RESULTS AND DISCUSSION

The plants planted in this study are selected lines of the crossing of Ciherang varieties x B11143D line through the backcross method. The lines are the selected BC_3F_6 generation from preliminary field tests conducted at KP Sukamandi in 2017.

Table 2 shows the diversity analysis of the 22 rice genotypes on 6 parameters

Based on various analysis of the significance of 5 % shows that there is a real effect of the progenies of Ciherang varieties x B11143D line to the plant height which can be seen on **Table 3**. The results of DMRT test in **Table 3** showed that the progenies of Ciherang x B11143D crosses that had the best plant height was 124.2.3 line with an average plant height of 115.283 cm followed by 94.3.3 line with an average plant height of 114.733 cm and 20.4.4 line with an average plant height of 114.400 cm. The character of plant height of the three lines most resembles Ciherang.

The plant height of the progenies resulting from the backcross of Ciherang x B11143D ranged from 109 to 115 cm, within the height range of the comparing varieties of Ciherang and Inpari 32. The Data pattern of plant height can be seen in **Figure 1**. The quality and quantity of a plant's yield is determined by the genetic factors of the plant (Sutrawati et al., 2019). The backcross method still maintains and does not eliminate the good characters in the parental restorer (Hasmeda et al., 2022). The plant height character of the recurrent parent, i.e Ciherang variety, is likely to remain in the progenies genome compared to that of the B11143D line as the donor parent.

The 1.5.1 line gives the shortest average plant height due to the low hara N element in the soil. According to Tando (2019), lack of nitrogen element causes the plant to become a dwarf, limited mounting system and yellow leaves.

Table 2. Results of analysis variance in all observation parameters.

Parameters Observed	F-Count	CV (%)
Plant Height	32,385*	0,77
Flag Leaf Length	33,109*	0,79
Flag Leaf Area	86,451*	0,54
Flowering Time	31,389*	0,86
Number of Tillers	28,927*	2,01
Number of Productive Tillers	10,665*	3,55
F-Table 5%	1,813	

Remarks: * = Significantly different at 5% level; CV=Coefficient of Variance

Plant Height

observed. There are significant differences between genotypes on all parameters observed. The coefficient of variation ranged from 0.54% to 3.55%. According to Gomez and Gomez (2010), a coefficient of variation of less than 20% indicates the data diversity is good and all data are valid.

Flag Leaf Length

Based on various analysis of the significance of 5 % shows that there is a real effect of the progenies of Ciherang varieties x B11143D line to the flag leaf length which can be seen on **Table 3**. In the observation of the flag leaf length parameter, the results of 5% DMRT test analysis showed that the best average flag leaf length were lines 94.3.3 and 124.2.3 with the same value of 50.383 cm, followed by line 20.4.4 with a value of 50.283 cm. The three lines had flag leaf length greater than Ciherang, but not significantly different. The results of the DMRT test on the mean values of the parameters of flag leaf length can be seen in **Table 3**.

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Table 3. The DMRT test of the parameters of plant height (cm), flag leaf length (cm), and flag leaf area (cm²)

Line/Variety	PH	FLL	FLA
1.2.4	112,483 def	49,533 def	99,067 def
1.5.1	109,267 h	48,367 h	96,733 h
2.3.3	113,583 bcde	49,600 bcde	99,200 bcde
11.2.1	113,800 bcd	49,667 bcd	99,333 bcd
15.1.3	110,650 gh	49,883 gh	99,767 gh
15.2.2	112,983 cde	49,667 cde	99,333 cde
20.4.4	114,400 bc	50,283 bc	100,567 bc
22.4.3	113,800 bcd	49,500 bcd	99,000 bcd
70.3.2	111,950 efg	49,883 efg	99,767 efg
72.2.3	113,550 bcde	49,533 bcde	99,067 bcde
94.3.3	114,733 b	50,383 b	100,767 b
96.5.4	112,467 def	49,683 def	99,367 def
100.5.1	112,967 cde	49,750 cde	99,500 cde
102.5.5	110,700 gh	48,367 gh	96,733 gh
105.5.1	110,900 fg	48,317 fg	96,567 fg
112.1.3	112,450 def	49,633 def	99,267 def
112.4.5	113,883 bcd	49,783 bcd	99,633 bcd
115.1.5	113,850 bcd	49,467 bcd	98,933 bcd
124.2.3	115,283 b	50,383 b	100,767 b
Ciherang	114,533 bc	49,200 bc	98,467 bc
B11143D line	124,350 a	55,033 a	111,433 a
Inpari 32	113,767 bcd	49,417 bcd	98,833 bcd

Remarks: Mean values followed by different letters in each column indicate that there are significant differences at the 5% DMRT level; PH = plant height; FLL = flag leaf length; FLA = flag leaf area.

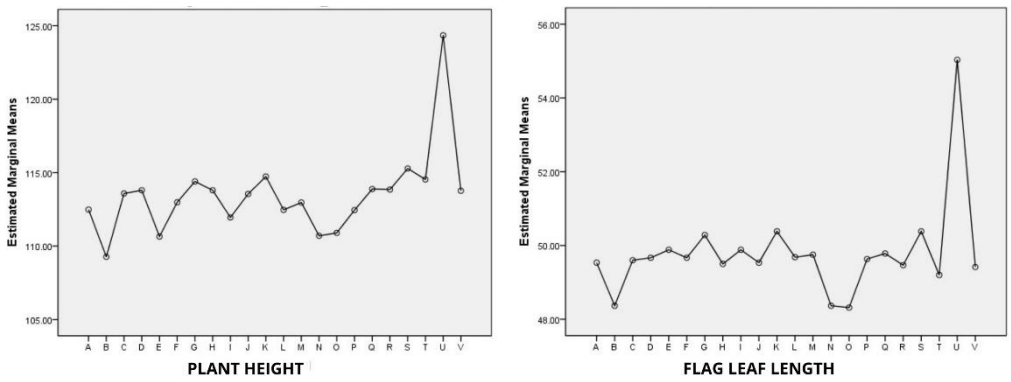

Figure 1. Data pattern of plant height and flag leaf length in rice.

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In the distribution of flag leaf length (**Figure 1**), it shows that the flag leaf length of Ciherang x B11143D progenies had higher values than Ciherang. Lines 94.3.3, 124.2.3, and 20.4.4 had the best average of flag leaf length. It was because of the introgression of genes from the B11143D line as a donor parent. According to Elfianis et al. (2021), backcrossing can carry good traits from the donor parents. The B11143D line has a longer flag leaf compared to the Ciherang variety. The B11143D line is NPT rice that has agronomic characters such as flowering time, flag leaf area, number of grains per panicle and 1000-grain weight that are superior to the Ciherang variety (Cica et al., 2023).

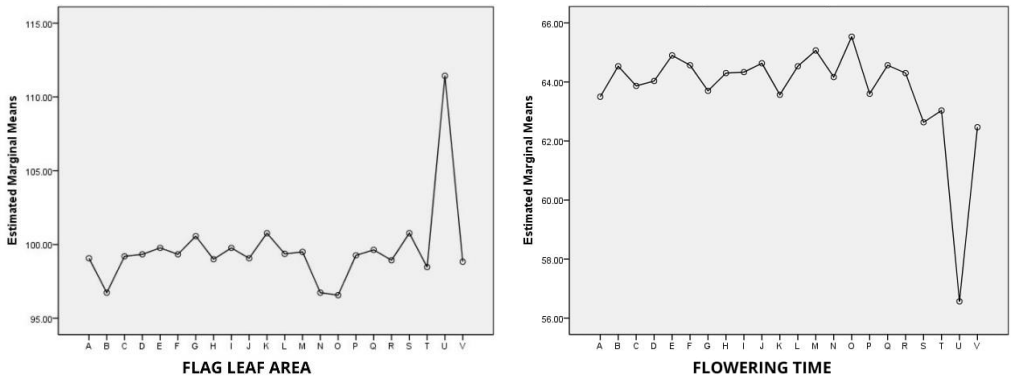

Figure 2. Data pattern of flag leaf area and flowering time in rice.

Flag Leaf Area

Based on various analysis of the significance of 5 % shows that there is a real effect of the progenies of Ciherang varieties x B11143D line to the flag leaf area. The results of the 5% DMRT test analysis, which can be seen in **Table 3**, showed that the average flag leaf area in the Ciherang x B11143D progenies was best found in the 94.3.3 and 124.2.3 lines, with the same value of 100.767 cm^2, followed by the 20.4.4 line, at 100.567 cm^2. The three lines have a larger flag leaf area than Ciherang, but not significantly.

The distribution of the flag leaf area shows that the flag leaf area of rice progenies resulting from the cross of Ciherang x B11143D had higher value than Ciherang as a restorer parent. According to Husna et al. (2022), the characteristics of the donor parent are integrated into the genomic background of the restorer parent. The B11143D line has the largest flag leaf area compared to others. This result is in line with Cica et al. (2023), which demonstrated that B11143D had a larger flag area than Ciherang. The effect of flag leaf length is in line with the growth of flag leaf width. Afrijon et al. (2021) argued that the longer the flag leaf, the more the flag leaf area increased. Flag leaf functions in improving photosynthetic performance and plays an important role in plant yield (Prasetia et al., 2022). Therefore, the flag leaf length and flag leaf area are important observation parameters for rice productivity. The data pattern of flag leaf area can be seen in **Figure 2**.

Flowering time

Based on various analysis of the significance of 5 % shows that there is a real effect of the progenies of Ciherang varieties x B11143D line to the flowering time. The flowering time performance in **Table 4** shows that most Ciherang x B11143D progenies have flowering time similar to Ciherang and Inpari 32. The pattern of flowering time data in **Figure 2** shows that the flowering time of the Ciherang x B11143D progenies ranged from 62 to 65 DAS, within the range of flowering time of Ciherang and Inpari 32 as comparison varieties. This is due to the selection carried out in previous field tests, which had selected progenies that have a flowering time similar to Ciherang as a recurrent parent.

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Table 4. The DMRT test of the parameters of flowering time (das), number of tillers, and number of productive tillers (stem at a clump)

Line/Variety	FT	T	PT
1.2.4	63,500 def	27,000 def	15,133 def
1.5.1	64,533 h	26,467 h	14,033 h
2.3.3	63,867 bcde	26,833 bcde	15,100 vcde
11.2.1	64,033 bcd	27,333 bcd	15,100 bcd
15.1.3	64,900 gh	27,733 gh	16,367 gh
15.2.2	64,567 cde	27,300 cde	15,900 cde
20.4.4	63,700 bc	27,700 bc	17,567 bc
22.4.3	64,300 bcd	27,367 bcd	16,133 bcd
70.3.2	64,333 efg	27,500 efg	15,567 efg
72.2.3	64,633 bcde	27,400 bcde	15,300 bcde
94.3.3	63,567 b	27,300 b	16,067 b
96.5.4	64,533 def	27,700 def	15,267 def
100.5.1	65,067 cde	27,533 cde	15,133 cde
102.5.5	64,167 gh	26,367 gh	14,100 gh
105.5.1	65,533 fg	27,467 fg	15,100 fg
112.1.3	63,600 def	27,600 def	16,267def
112.4.5	64,567 bcd	27,333 bcd	15,400 bcd
115.1.5	64,300 bcd	27,700 bcd	15,467 bcd
124.2.3	62,633 b	27,867 b	18,067 b
Ciherang	63,033 bc	29,967 bc	14,033 bc
B11143D line	56,567 a	20,567 a	14,300 a
Inpari 32	62,467bcd	29,533 bcd	14,533 bcd

Remarks: Mean values followed by different letters in each column indicate that there are significant differences at the 5% DMRT level, FT = flowering time; T = number of tillers; PT = number of productive tillers

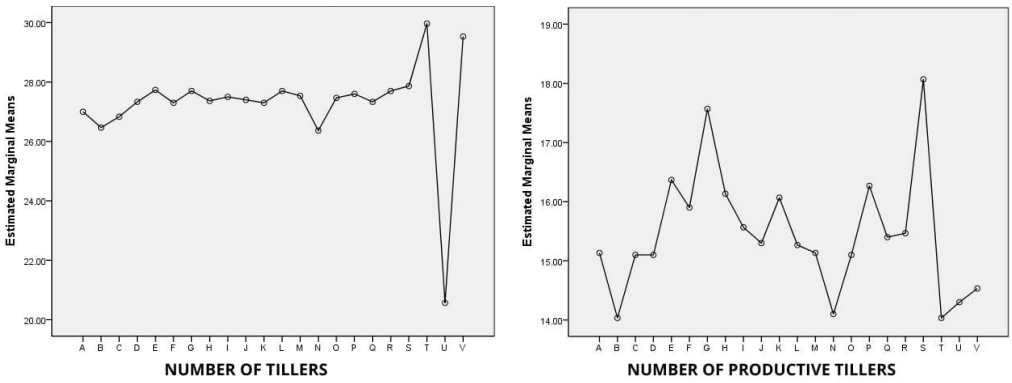

Figure 3. Data pattern number of tillers and number of productive tillers in rice.

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Number of Tillers and Number of Productive Tillers

Based on various analysis of the significance of 5 % shows that there is a real effect of the progenies of Ciherang varieties x B11143D line to the number of tillers and number of productive tillers. The DMRT test in **Table 4** shows that the lines with the best value of number of tillers and number of productive tillers are 124.3.2 line with 27.867 tillers and 18.067 productive tillers, followed by 20.4.4 line with 27,700 tillers and 17,567 productive tillers, and 94.3.3 line with 27,300 tillers and 16,067 productive tillers.

Those three lines have higher values of the number of tillers and number of productive tillers than Ciherang. This was because the target traits from B11143D, the donor parent, have successfully entered into the Ciherang x B11143D progenies genomes. Susilowati et al. (2014) reported that B11143D line is the best donor parent for improving Ciherang variety. The data pattern of number of tillers and number of productive tillers can be seen in **Figure 3**.

The B11143D line is a NPT rice that has valuable agronomic characters, one of which is the smaller number of tillers, but almost all of them are productive tillers. Number of tillers will affect the number of productive tillers. According to Armana (2020) the number of productive tillers is closely related to the maximum number of tillers. The more the number of tillers produced per clump, the more productive tillers produced. The more number of productive tillers are, the more rice productivity increases.

The number difference between tillers and number of productive tillers from any treatment can also be due to the role of the phosphorus nutrients in the soil. Phosphorus nutrients play a role in the plant's growth phase and serve to spur the growth of roots and in addition to the number of tillers (Kurnia et al. 2021).

CONCLUSION

Based on the results of the cultivation of Ciherang x B11143D progenies and comparison varieties in Telagasari District Karawang showed that the best lines were 124.2.3 line with plant height of 115.283 cm, flag leaf length of 50.383 cm, flag leaf area of 100.767 cm^2, flowering time of 62.633 DAS, number of tillers of 27.867 and number of productive tillers of 18.067 stems per clump; 94.3.3 and 20.4.4 lines ranked as the second and third best progenies. The vegetative characters possessed by the three selected lines are expected to affect the productivity to be better than the comparison varieties.

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