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GROWTH OF RICE (*Oryza sativa*) VARIETIES: MENDAWAK, INPARI 34, CIHERANG, AND BANGIR IN CIGANJENG VILLAGE, PANGANDARAN DISTRICT

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Abstract. *Type of rice varieties is one of the important factors that affecting rice production. For countries, rice breeders of Indonesia can take advantage of specific environmental potential in determining the distribution policy of superior varieties. The purpose of this study was to observe the appearance of plant height and the number of tillers of four rice varieties in Ciganjeng Village, namely Mendawak, Inpari 34, Ciherang, and Bangir. The design used completely randomized block design and repeated three times. Observations were carried out eight times in the vegetative phase, started from 14 days to 63 days after planting. This research was participatory and involved farmers. Farmers roled as observers to measure and record observation. All data analyzed by ANOVA with tukey's HSD test as post hoc test. The results showed that both Inpari 34 and Bangir variety had the highest average plant height growth while Mendawak and Bangir has the highest average number of tillers.*

Keywords*: rice variety, plant height, number of tiller*

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INTRODUCTION

Rice is one of the most important cereal grain for human consumption globally and the most important staple food for Indonesia. The country has with 150 kg per capita and year one of the highest rice consumption rates in the world. Despite the fact that Indonesia is one of the largest rice producers of the world, the country is required to import rice to meet the national demand. With the rapid population growth of 0.86% and high urbanisation rates of 2.27% it is expected that Indonesia's urban population will be expanding from 55% in 2017 to 68% in 2025 (World Bank 2015; CIA, 2018; FAO, 2018) leading to increased rice consumption. This effect is slightly diminished by greater affluence of the population and the domestic rice consumption annual growth rate is with 0.53% lower than population growth Nevertheless, the demographic change puts pressure on the rice sector, suggesting that an

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increase in rice production is required in order to avoid a national food crisis. The national rice production reached 79.14 million tons in 2016, but the production has not been able to meet the needs. The government imported 1.3 million tons of rice in 2016 to cover the shortage of rice needs (BPS, 2017). Rice productivity in Indonesian rain-fed smallholder systems is generally low due to lack of various resources, such as low access to credits and farm inputs, low market integration and lack of technologies to take advantage from the yield potential of superior varieties (Lopulisa et al, 2018).

Still, the use of superior rice varieties is one of the important factors that affect the rice productivity. In Indonesia, superior varieties have a strategic role to support the success of rice farming (Ningsih & Dwi, 2017). The Indonesian government introduced new superior varieties such as IR5 and IR8 during the "green revolution". Although being disseminated widely, the superior varieties are not suitable in all areas of Indonesia and have been disadopted (Iskandar and Iskandar, 2018). Therefore, the superior varieties should be developed for the location-specific context. Locally adapted varieties show higher productivity and are better accepted and used by rice farmers. These location-specific breeding strategies are particularly required for countries with a wide biogeophysical and agroecological diversity such as Indonesia. Local breeders use the advantage of propagating varieties with a specific environmental potential with a best fit to local conditions, which determines the impact and adoption of superior varieties (Baihaki & Wicaksana, 2005).

The on-farm experiment for this research is conducted in Ciganjeng village, Padaherang subdistrict, Pangandaran district, West Java. Rice production in Ciganjeng is based on lowland rain-fed farming systems. A farmers' survey conducted in 2017 with 64 farmers reveals, that the Ciganjeng farms paddy rice in average on 0.364 hectares. While only 22% of the farmers use organic fertilizer (manure and compost) in their rice fields, the majority (56%) apply synthetic fertilizer to maintain soil fertility. 22% of the farmers follow an integrated soil fertility management strategies, using both - organic and inorganic - inputs. A high proportion of the land is flood-prone often causing harvest failures in the rainy season. Flood-tolerance is therefore one of the most relevant traits for Ciganjeng farmers.

In order to overcome this problem of flooding and salinity, the Indonesian Center for Rice Research (ICRR) recommends two stress-tolerant varieties to be applied in Ciganjeng village: Mendawak and Inpari 34. The Mendawak variety is claimed to be flood-resistant, while Inpari 34 is described to tolerate high salinity. For the control treatments the variety Ciherang is chosen, as the majority (53%) of the farmers use Ciherang. Another control is the local variety Bangir that is used in the village but has a rather low productivity. This paper aims at comparing the performance of those four varieties in terms of their morphological features, of which plant height and numbers of tillers have been chosen.

MATERIAL AND METHOD

Study location

An on-farm experiment was established in Ciganjeng villlage, Padaherang subdistrict, Pangandaran district, West Java (7°34′44″S, 108°42′43″E, altitude: 12 m) on a site that is representative of smallholder rice production in the area and nearby the main road in order to ensure generalizability, visibility and outreach. The site has been under rice cultivation

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for the past 20 years. During that period, rice has been cultivated twice a year by use of chemical fertilizer. The location has type B climate that is wet according to Schmidt-Ferguson classification. The soils are broadly classified as dusty clay. The plot has been rented by IPPHTI (Ikatan Petani Pengendalian Hama Terpadu Indonesia), the Indonesian Integrated Pest Management farmer association. IPPHTI also acts as main partner in this research with its members acting as farmer researchers.

Experimental design and treatments

An experimental plot has been set up in 30th October 2017. The experiment was completely randomised with three replicates of four treatments. Two variety treatments, i.e. Mendawak and Inpari 34 were compared to two control treatments, i.e. Ciherang and Bangir, in one growing season. The treatments used 5 kg of seed per hectare. As each plot measured 16 m² (8 m × 2 m) with a 0,5 m buffer in between, the size of the experimental plot was 200 m². The plot management was in line with the System of Rice Intensification (SRI) combined with the principles of organic farming. The land was prepared by mechanical ploughing. Prior planting, 10 tons/ha goat manure was applied. Eight days after seeding the plants were transplanted into the field. The planting technique followed jejer manten. Nursery performed on eight days after seedling . The plots were fertilized at day 21 (day after planting) and 42 (day after planting) using a knapsack sprayer filled with organic.

Data collection

This study follows the principles of participatory farmer field research, involving 10 IPPHTI farmers in the design, implementation, data recording and assessment of the results. The goal of the research, testing stress-tolerant varieties, was based on farmers' preferences for this season. Farmers acted as observers and recorded the observations. For this purpose so-called farmer field labs following the principles of farmer field schools were established, in which farmer researchers were trained to perform their field research tasks according to standard research protocols. The observations were conducted in the vegetative growth phase (14 days after planting (dap) to 63 dap) (Soemartono and Hardjono 1980). 63 days after planting the rice started the generative phase with no additional height and tiller growth. Plant height and number of tillers were observed on a weekly basis (every Thursday) for eight times.

Data analysis

Height and number of tillers was calculated by dividing the mean for each treatment at the 8 dates. Differences between the varieties were tested via an ANOVA post-hoc analysis using the Tukey's Tukey's honest significance test or Tukey's HSD. The data was computed using the PKBT stat software.

RESULT AND DISCUSSION

Plant Height

The plant height is one of parameters applied to indicate the effect of environment to growth (Sitompul & Guritno, 1995). Significant differences of plant height among all tested varieties were observed 35 days after planting (Table 1).

Inpari 34 variety had the highest height in all observations, except in 14 days after planting, and therefore had the highest final height with 101.33 cm followed by Bangir, Ciherang and Mendawak varieties (Table 2). While the height (63 dap) between Inpari 34 and Bangir was not significantly different, both varieties were significantly higher at 95%

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confidence level compared to Ciherang and Mendawak varieties. The latter didn't show any significant differences. The pattern of growth among varieties was different which related to difference on the genetic response to environment (Sitaresmi, 2016). At 42 and 49 dap Inpari 34 was significantly higher than the other three varieties, but Bangir started to follow Inpari 34 at 56 dap.

This study showed a high variation of plant height growth for all tested varieties, indicated by coefficient of variation (C.V.) of more than 10 (Table 3). High C.V. suggests a strong effect of environmental factors, crop types and other traits, which is common for on-farm trials having less controlled conditions (Gomez and Gomez, 1995; Gaspersz, 2006). This study also showed the significant plant growth only occurred in 21 days after planting ($P < 0.05$) (Table 3).

The highest weekly plant height growth was attained in 42 days after planting (13.77 cm), while the lowest average of plant height obtained in 56 days after planting (6.19 cm). The average growth rate for all varieties was 7.48 cm per week (Table 4).

Inpari 34 showed highest average growth rate (10.33 cm per week), followed by Bangir (9.44 cm), Mendawak (8.11 cm), and Ciherang (7.95 cm). Both cultivars - Inpari 34 and Bangir - have higher growth rate compared with the two others. The differences in genetic make-up and the physiological response to environment conditions may explain this result (Sugeng 2001).

Table 1. Analysis of Variance for Plant Height in 14 - 63 Days After Planting

Observation	Varieties	C.V. (%)
14 dap	ns	5.00
21 dap	ns	6.30
28 dap	ns	5.71
35 dap	*	4.96
42 dap	**	1.06
49 dap	**	2.66
56 dap	**	3.29
63 dap	**	2.24

***)** significant in P<0.05; **) significant in P<0.01; ns = non significant

Table 2. Average of Plant Height in 14 – 63 days after planting (cm)

Variety	14 dap	21 dap	28 dap	35 dap	42 dap	49 dap	56 dap	63 dap
Mendawak	27.07	35.67	46.80	52.53^{b}	66.13^{c}	73.13^{c}	78.33^{b}	83.87^{b}
Inpari 34	29.00	42.33	54.13	62.47^{a}	79.27^{a}	87.07^{a}	93.93^{a}	101.33^{a}
Ciherang	30.67	40.93	50.33	56.20^{ab}	65.73^{c}	73.07^{c}	78.82^{b}	86.33^{b}
Bangir	30.13	41.73	52.20	58.07^{ab}	73.20^{b}	79.80^{b}	86.73^{a}	96.20^{a}

Note: number followed by the same letter is non significant (P<0.05)

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Table 3. Analysis of Variation of Plant Height Growth in 21 - 63 days after planting

Observation	Varieties	C.V. (%)
21 dap	*	11.82
28 dap	ns	16.40
35 dap	ns	19.49
42 dap	ns	20.47
49 dap	ns	25.05
56 dap	ns	33.15
63 dap	ns	36.65

***)** significant in P<0.05; **) significant in P<0.01; ns = non significant

Table 4. Weekly Averages of Plant Height Growth in 21 – 63 days after planting (cm)

Varieties	21 dap	28 dap	35 dap	42 dap	49 dap	56 dap	63 dap	Average
Mendawak	8.60[b]	11.13	5.73	13.60	7.00	5.20	5.53	8.11[b]
Inpari 34	13.33[a]	11.80	8.33	16.80	7.80	6.87	7.40	10.33[a]
Ciherang	10.27[ab]	9.40	5.87	9.53	7.33	5.75	7.52	7.95[b]
Bangir	11.60[ab]	10.47	5.87	15.13	6.60	6.93	9.47	9.44[a]
Average	10.95	10.70	6.45	13.77	7.18	6.19	7.48	7.48

Note: the number followed by the same letter is non significant (P > 0.05)

Number of Tillers

The number of tillers is one important parameter for rice health and vigour. A high number of tillers usually correlate with high rice productivity (Simanjuntak, 2015). The results showed that the number of tillers of all cultivars were similar in 14 to 35 days after planting (ANOVA, P>0.05) (Table 5). After 35 days, the differences of physiological response to the environmental conditions produced a significant different number of tillers among cultivars (ANOVA, P<0.01 and P<0.05) (Table 5), which continued until the final observation. A further statistical test showed that the total number of tillers of Mendawak was from 42 dap onwards significantly higher than in the other three varieties (Table 6).

While the growth pattern of the trait plant height continuously increases until 63 dap, the number of tillers decreased after 56 days after planting (Table2, Figure 2), which is mainly caused by the death of some tillers due to reduced photosynthates. This pattern agrees with the findings of Hatta et al. (2010) that the maximum number of tillers is reached at 50-60 days after planting. Based on the number of tillers formed, it shows that Mendawak and Bangir have very high tillering ability, meanwhile Inpari 34 and Ciherang have good tillering ability in accordance to the Rice Standard Evaluation System. According to IRRI (2002), the Rice Standard Evaluation System comprises, very high (more than 25 tillers/plant), good (20-25 tillers/plant), medium (10-19 tillers/plant), low (5-9 tillers/plant), and very low (less than 5 tillers/plant) (IRRI, 2002).

The growth rate of rice influenced by internal factors which consist of genetic characteristic or agronomic traits and also by external factors such as environmental condition (including soil climate) and biotic factors. The

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differences in the number of tillers in each variety are suspected due to the above mentioned factors. This is in line with the findings shown by Anhar et al. (2016) that the differences in plant height and number of tillers caused by the differences in genetic characteristics that each variety have.

Besides the total numbers of tillers in each variety, the analysis also conducted towards the weekly addition of the numbers of tillers. The addition of the numbers of tillers is the subtraction of the total numbers of tillers during the observation with the total numbers of tillers from the previous week. Each variety shows very significant rate of addition of the numbers of tillers in 28 dap. In 21-35 dap, the addition of the numbers of tillers increased and the optimum addition occurred in 28-35 dap. During a week from 28-35 dap, the average addition of the numbers of tillers in each variety reached 13.72 tillers. Throughout that week, Mendawak variety has the highest addition of the numbers of tillers that reaches 15.37 tillers. The addition of total numbers of tillers then decreased in 42 and 48 dap. Afterwards, in 56 and 63 dap, the numbers of tillers even lessened.

Table 5. Analysis of Variation for Number of Tiller in 14 - 63 days after planting

Observation	Varieties	C.V. (%)
14 dap	ns	11.93
21 dap	ns	14.47
28 dap	ns	7.35
35 dap	ns	7.87
42 dap	**	5.26
49 dap	*	7.57
56 dap	**	7.49
63 dap	**	11.10

***)** significant in P<0.05; **) significant in P<0.01; ns= non significant

Rice plant has three growth phases, which are vegetative phase, reproduction phase, and ripening phase. In general, the vegetative phase occurs in 0-60 dap, reproduction phase occurs in 60-90 dap, and ripening phase occurs in 90-120 dap. The maximum vegetative phase for all verities tested in this research occurred in 35-42 daps. This can be observed by looking at the increasing plant growth and number of tillers addition which occurred optimally in 35-42 daps. The findings also shows that all tested varieties started the reproduction phase in 56 dap. This can be observed by looking at the decreasing number of tillers. The number of tillers decreased because the formed tillers are competing for nutrition absorption; meanwhile nutrition is also needed for flowering. Therefore the tillers that could not compete will die. This process occurs until the end of reproduction phase.

From this research, it can be inferred that Inpari 34 and Bangir are the varieties with highest plant height. Compared to Mendawak and Ciherang, Inpari 34 and Bangir have the best addition of plant height. In the characteristic of number of tillers, both Mendawak and Bangir are the variety with the highest number of tillers. Furthermore, both of these varieties have the best addition of the number of tillers.

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From this research, it is known that the local variety of Bangir grew well according to the rate of plant height and number of tillers. Bangir variety also being suspected for its ability to utilise the growing environment, because according to Londra and Aribawa (2014), the plants which are able to utilise the environment will show maximum growth.

Table 6. Post Hoc Test for Average Number of Tillers in 14 - 63 days after planting

Varieties	14 dap	21 dap	28 dap	35 dap	42 dap	49 dap	56 dap	63 dap
Mendawak	6.60	12.20	25.33	41.07	45.47[a]	47.80[a]	40.60[a]	34.89[a]
Inpari 34	5.60	12.73	22.80	36.07	36.80[b]	38.73[b]	30.67[b]	24.00[b]
Ciherang	6.00	11.47	20.73	33.33	34.13[b]	35.33[b]	29.35[b]	22.78[b]
Bangir	5.27	10.07	21.33	34.60	38.47[b]	39.60[ab]	33.87[ab]	30.44[ab]

Note: the number followed by the same alphabet is non significant

Tabel 7. The Average of Numbers of Tillers in 21 – 63 dap

Variety	21 dap	28 dap	35 dap	42 dap	49 dap	56 dap	63 dap	Average
Mendawak	5.6	13.13[a]	15.73	4.4	2.33	-7.2	-5.71	4.04[a]
Inpari 34	7.13	10.07[bc]	13.27	0.73	1.93	-8.07	-6.67	2.63[b]
Ciherang	5.47	9.27[c]	12.6	0.8	1.2	-5.98	-6.57	2.39[b]
Bangir	4.8	11.27[b]	13.27	3.87	1.13	-5.73	-3.42	3.60[ab]
Average	5.75	10.94	13.72	2.45	1.65	-6.75	-5.59	3.17

Note: the number followed by the same alphabet is non significant

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