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№ 9344

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November 21, 2022

Growth Response and Seed Production of Several Varieties of Rice (*Oryza sativa* L.) in Acid Soil

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Abstract: The cause of the soil to become acidic, this occurs by several things, such as excessive inorganic fertilization such as Urea, Za, high rainfall, frequent waterlogging of the soil and excess elements of Fe (Iron), Al (Aluminum) and Cu (Copper). The development of tolerant varieties is one alternative to increase the efficiency of cultivation in acid soils. Selection of tolerant rice varieties in acid soil needs to be done because the number is still limited. Meanwhile, the potential for acid soil for farming is quite extensive. This activity was carried out in the experimental area of PT. Sang Hyang Seri (Persero) Gedung Rejo Village, Kec. Muncar Kab. Banyuwangi. This study used a non-factorial Randomized Block Design, with 4 varieties, namely Logawa, Inpari 32, Situ Bagendit, Siliwangi, and replicated 6 times. Data analysis used the F test (ANOVA) and if there was a significant difference, then proceed with the calculation of BNJ (Honest Significant Difference) with an error rate of 5%. The results showed that Siliwangi varieties has tolerance in acid soils level. Inpari 32 variety has a high tolerance level in acid soils, because it is able to produce a high number of productive tillers in vegetative and generative phase and plant height in generative phase. In other hand, Logawa varieties has high production rate than other varieties. It can be seen in the parameters potential yield, Logawa variety has a potential yield of 9,29 ton/ha, and this yield was higher than the description of the variety, which was 7.5 tons/ha.

Keywords : acid soil, Inpari 32, Logawa, seed production

1. Introduction

Rice (*Oryza sativa* L.) is the main staple food source for the Indonesian population. Development continues to be carried out by utilizing Indonesia's natural wealth with a combination of technology in order to obtain abundant harvests. The agricultural sector plays an important role in providing food for the entire population, raw materials for industry, and for export trade [1].

Indonesia has a land area of 188.2 ha, from 148 million of dry land and the rest of the wetlands (peat, tidal) as well as permanent land. Soil diversity, physiography, parent material, climate, elevation, and environment make Indonesia's natural resources diverse, both in terms of potential and level of land tenure in developing the agricultural sector [2] .

One of the problems faced in rice production in Indonesia is the use of acid land for rice cultivation. Acidic soils are reported to have low pH (4.2-5.0), high Al, and low nutrients [3]. Rice plants grown on acid soils show a decrease in the quality and quantity of production due to many factors such as exposure to heavy metal Al, inhibition of root growth, and decreased microbial activity associated with the root system of rice plants [4].

The development of acid soil tolerant varieties is an alternative way to increase the efficiency of rice cultivation. Varieties tolerant of acid soils are reported to be dominated by local varieties aged 5-6 months with low yields [5]. On the other hand, high-yielding varieties circulating in the market have not been widely reported regarding their tolerance to acid soil conditions. The development of high-yielding varieties that are tolerant of acid soils must also have other important characteristics such as higher yield potential and resistance to pests and diseases. Therefore, this study aimed to examine the growth

response and seed production of Logawa, Inpari 32, Situ Bagendit, and Siliwangi varieties of rice under acidic soil conditions.

2. Implementation method

The research was carried out from December 2021 to April 2022 on the experimental land owned by PT. Sang Hyang Seed Production Unit Series Muncar Kab. Banyuwangi. This study used a non-factorial randomized block design with 1 factor consisted of four rice varieties includes Logawa, Inpari 32, Situ Bagendit, and Siliwangi. Each treatment was repeated 6 times for a total of 24 experimental units. The data obtained were analyzed using ANOVA (Analysis of Variance). If the data are significantly different, then proceed with the Tukey HSD test with a significance level of 5%.

3. Experimentation

The acid soil used is from Sumbermulyo, Pesanggaran, Banyuwangi with characteristics such as clay soil, pH 5, Copper -0.279 ppm, Iron 12,273 ppm, and Aluminum 251,615 ppm. The soil was put into a 10 L bucket to be used as a planting medium. Rice seeds are soaked in clean water for 24 hours. After that, the seeds were drained for 24 hours until coleoptile appeared. Furthermore, the seeds are sown in polybags containing planting media until the age of 10-14 days after sowing (DAS). After sowing, one seed of rice seedling was transplanted into a bucket filled with acid soil media. Embroidery is done if there are abnormalities, dead, or attacks by pests and diseases. Weeding is also done when weeds grow. Watering is done when the planting medium dries. Inundation is carried out for 3 days, then the water is removed so that the soil conditions are saturated and not waterlogged. Fertilization is carried out according to the level of green color of the rice leaves. fertilizers for rice plants are listed in Table 1. Pest and plant disease control is carried out using pesticides in Table 2. Harvesting is done when the rice plants reach physiological maturity, ie 90-95% of the grains have turned yellow. Harvesting is done when the weather is sunny.

Table 1. Dosage of fertilization on rice plants

Fertilizer	Dosage (kg)	Fertilization schedule (day after planting)			Total (g)
		15 DAP	25 DAP	45 DAP	
NPK Mutiara	100	6,9	-	-	6,9
	150	-	10	-	10
	100	-	-	6,9	6,9
KCL	50	3,4	-	-	3,4
	100	-	6,9	-	6,9

Table 2. Dosage of pesticides for controlling pests and plant diseases in rice seedlings

Pesticide	Pest	Concentration (ml/L)
Regent 50 SC 50 ml	Grass hopper	2
Regent 50 SC 50 ml	Rice ear bug	2

Observations were carried out quantitative observations included plant height (cm) and the number of tillers observed at the vegetative phase at 25 day after plating (DAP). Generative phase observed at plant height (cm) and the number of productive tillers and yield potential per hectare.

4. Result and discussion

The results of the sorting treatment on acid soils with a pH of 5 are presented in Table 3. Parameters in vegetative phase of plant height and number of tillers showed significantly different responses. On the other hand, parameters in the generative phase such as plant height and yield potential per Ha showed very significantly different responses. However, the parameters number of productive tillers in generative phase did not show significantly.

Table 3. Responses of various growth parameters on rice varieties grown on acid soil

No	Parameters	Notation Varieties
A.	Vegetative phase	
1.	Plant height	*
2.	Number of tillers	*
B.	Generative phase	
1.	Plant height	**
2.	Number of productive tillers	ns
3.	Yield potential per Ha	**

Notes: significantly different(*), very significantly different (**), not significantly different (ns)

4.1 Response of rice plants in the vegetative phase

The four rice varieties tested showed a significantly different effect on acid soil treatment on all parameters observed in the vegetative phase.

4.1.1 Plant height

The results showed that the Siliwangi variety had the highest plant height of 56.63 cm, while Inpari 32 had the lowest plant height of 49.83 cm (Table 4).

Table 4. Response of plant height on rice varieties grown on acid soil

Varieties	Plant height (cm)
Inpari 32	49,83 a
Logawa	54,20 ab
Siliwangi	56,63 b
Situ Bagendit	53,73 ab

*Numbers followed by the same letter in one column show no significant difference according to the Tukey HSD test with a significant level of 5%.

The difference in plant height in each variety that grows on acid soils is due to different genetic characteristics so that they can adapt to the environment differently. [6] explained that differences in the composition of hereditary qualities were one of the factors that caused the appearance of plants to vary such as plant height. Rice plant height is often used in conjunction with expansion parameters, but high plant growth does not guarantee greater yields. [7] argues that the difference in plant height is thought to be due to genetic factors. The taller the plant, the less the number of children and also the number of children that is positively correlated with the results and vice versa. the height of rice plants is also influenced by environmental factors [8].

4.1.2 Number of tillers

The results showed that Inpari 32 had the highest number of tillers at 38.66, not significantly different from Situ Bagendit. On the other hand, Logawa had the lowest number of tillers at 28.33, not significantly different from Siliwangi (Table 6).

This result was expected because the Inpari 32 variety was more tolerant of acid soil stress so root growth and development were not disturbed. [9] explained that plants tolerant to Al stress will experience little or no damage, so they are able to grow and develop properly. On the other hand, the Logawa variety had the lowest number of offspring because it was not tolerant to the soil so the formation of tillers was disturbed. [10] explained that the accessibility of supplements in acid soils is very limited and the Al content at a pH below 5.5 limits the absorption not exceeding the maximum

limit. Micronutrients are needed by plants in small amounts, so if the amount is excessive it will trigger root growth. The critical threshold for aluminum poisoning in rice plants is 300 ppm [11]

Table 6. Response of number of tillers on rice varieties grown on acid soil

Varieties	Number of tillers (stem)
Inpari 32	38,66 b
Logawa	28,33 a
Siliwangi	29,00 a
Situ Bagendit	36,33 ab

*Numbers followed by the same letter in one column show no significant difference according to the Tukey HSD test with a significant level of 5%.

4.2 Response of rice plants in the generative phase

The four rice varieties tested showed significantly different effects on acid soil treatment on all parameters observed in the generative phase.

4.2.1 Plant height

The results showed that Inpari 32 had the largest plant height of 106.13 cm, but it was not significantly different from Siliwangi (Table 7).

Table 7. Response of plant height on rice varieties grown on acid soil

Varieties	Plant height (cm)	Variety description (cm)
Inpari 32	106,13 b	99-105
Logawa	94,3 a	81 – 94
Siliwangi	103,27 b	± 111
Situ Bagendit	94,8 a	± 99

*Numbers followed by the same letter in one column show no significant difference according to the Tukey HSD test with a significant level of 5%.

This is because Inpari 32 variety has a good genotypic resistance response to Al stress. [6] explained that the ratio of plant height was caused by heredity from a genotype. The Situ Bagendit variety showed plant height that did not match the variability outline because its genetic characteristics failed to adapt to Al stress. [12] explained that each variety has a resistance response based on the more dominant genotype. Plants that are susceptible to Al stress are caused by the influence of environmental factors. In addition, growth inhibition due to stress is also caused by microclimate, nutrient availability and soil fertility level [13].

4.2.2 Number of productive tillers

The results showed that Inpari 32 had the highest number of tillers, namely 87.82 tillers, but it was not significantly different from Situ Bagendit. On the other hand, Logawa had the lowest tiller, which was 64.50 tillers, not significantly different from Siliwangi (Table 8).

However, the four varieties did not show significant differences. This result was due to the higher the number of tillers, the more productive tillers were produced. [14] explained that there was a positive relationship between the highest number of tillers and the number of productive tillers. A small number of productive tillers can increase yield potential because it increases nutrient flow in panicle formation [15]. A high percentage of productive tillers and a high percentage of pithy grain per panicle have the opportunity to achieve high productivity. On the other hand, the high percentage of unproductive tillers can become a burden on plants in forming pithy grains [16].

Table 8. Response of number of productive tillers on rice varieties grown on acid soil

Varietas	Number of tillers	
	Generative phase	Productive
Inpari 32	87,82 c	47,17
Logawa	64,50 a	50,67
Siliwangi	73,08 ab	45,5
Situ Bagendit	82,17 bc	46,67

*Numbers followed by the same letter in one column show no significant difference according to the Tukey HSD test with a significant level of 5%.

4.2.3 Potential yield per Hectare

The results showed that Logawa had the highest yield potential of 9.29 tons/ha, significantly different from other varieties. On the other hand, Inpari 32 has the lowest yield potential of 6.22 tons/ha (Table 9).

Table 9. Observation of production and potential per hectare of various varieties of rice on acid soil

Variety	Potential yield per Hectare (ton/ha)	
	acid soil pH	Variety description
Inpari 32	6,22 a	8,42
Logawa	9,29 c	7,5
Siliwangi	7,09 ab	10,7
Situ Bagendit	6,85 a	6

*Numbers followed by the same letter in one column show no significant difference according to the Tukey HSD test with a significant level of 5%.

The Logawa variety has the longest panicles and the highest number of grains, thus making the potential yield per hectare higher than the other three varieties. [17] reported that the amount of grain was influenced by the length of the panicle formed. The elemental content of Al of 251,651 ppm has not resulted in poisoning for Logawa rice plants, so it can produce high yield potential. [11] explains that the critical threshold for Al-stressed rice plants is 300 ppm. The high yield potential of the Logawa variety indicates that this variety is tolerant to acid soils which is higher than the variety description.

On the other hand, the Inpari 32 variety has the shortest panicles so the amount of grain and yield potential is less. Inpari 32 has inhibited panicle elongation when grown in acid soils. The number of grains per panicle produced will be better if it is supported by suitable environmental conditions such as sufficient lighting for photosynthesis, sufficient nutrients, and sufficient water during seed filling. Nutrient deficiencies can also limit panicle elongation and seed filling. [18] reported that when growing in a stressful environment, plants will use their energy to survive the stress rather than grain filling.

5. Conclusion

Of the four varieties tested, namely Logawa, Inpari 32, Situ bagendit and Siliwangi varieties has tolerance in acid soils level. Inpari 32 variety has a high tolerance level in acid soils, because it is able to produce a high number of productive tillers in vegetative and generative phase and plant height in generative phase. In other hand, Logawa varieties has high production rate than other varieties. It can be seen in the parameters potential yield, Logawa variety has a potential yield of 9,29 ton/ha, and this yield was higher than the description of the variety, which was 7.5 tons/ha.

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