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Research Paper

Optimization of Rice Yield of Nutri Zinc and Inpari 32 Varieties through Fertilizer Combination in Rainfed Rice Fields of Lahat, South Sumatra, Indonesia

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Abstract
Rice (*Oryza sativa* L.) is one of the main food commodities in Indonesia and has a strategic role in national food security. High quality rice production is a major factor in meeting the increasing consumption needs of the community. However, agricultural conditions in Indonesia still face various challenges, especially in rainfed rice fields which are highly dependent on rainfall and often experience problems in crop production. This research was conducted in Prabu Menang Village, East Merapi District, Lahat Regency, South Sumatra Province, from January to April 2024. The method used was quantitative research with a split plot design. The main plot was a combination of fertilizers consisting of three treatments: (1) NPK (300 kg/ha), Urea (150 kg/ha), and LOF (Liquid Organic Fertilizer) (25 ml/L) ; (2) NPK (300 kg/ha) and Urea (150 kg/ha) fertilizer; and (3) LOF (25 ml/L). The subplots consisted of two rice varieties, Nutri Zinc and Inpari 32, so there were 6 treatment combinations repeated 4 times, resulting in a total of 24 units experimental . This study aimed to analyze the effect of fertilizer combinations on the growth and yield of Nutri Zinc and Inpari 32 varieties in rainfed fields. The results showed that the combination of fertilizers had significant effect on plant height and number of tillers. Inpari 32 variety was with superior higher plant height and more tillers than the Nutri Zinc variety. The combination of NPK, Urea, and LOF fertilizers with the Inpari 32 variety produced the highest productivity of 4.67 tons/ha, while Nutri zink variety with the same fertilizer is 4.41 tons/ha. The combination of NPK and Urea fertilizers with the Inpari 32 variety is 4.60 tons/ha and Nutri zink variety is 4.35 tons/ha. The use of LOF alone resulted in a lower number of tillers and productivity, 3.92 tons/ha for Inpari 32 variety and 3.66 tons/ha for Nutri Zink variety.

Keywords
Nutri Zinc, Inpari 32, rice yield, rainfed rice field

1. INTRODUCTION

Regency Lahat, South Sumatra, Provinceis one of the regions with a significant area of Rainfed Rice Fields (RRF). However, the problem is this agricultural system in the area faces challenges inform of erratic rainfall fluctuations, limited water resources and varying soil. Therefore, innovations in cultivation techniques are needed to improve rice production and quality, especially through effective and efficient fertilization strategies.

Nutri Zinc and Inpari 32 are superior varieties that were developed to improve the quality and quantity of crop yields. Nutri Zinc has the advantage of higher zinc content than other varieties, so it can contribute to overcoming the problem of zinc deficiency in the community, especially children who are vulnerable to growth disorders due to lack of this micronutrient. Stunting is one of the most serious effects of zinc deficiency (Chairuman et al., 2022). Stunting poses a serious danger to Indonesia's human quality and competitiveness. Meanwhile, Inpari 32 is known for its high productivity and tolerance environmental to suboptimal conditionsincluding, to drought and pest attacks.

One of the main challenges in cultivating high-yielding rice varieties RRF is how to ensure adequate nutrient availability throughout the plant growth cycle. The right combination of fertilizers is needed to optimize nutrient uptake by plants so as to increase productivity and crop quality.

Proper fertilization is one of the key factors in improving rice yield and quality. Unbalanced fertilizer use can cause nutrient deficiencies, reduce yield quality, and negatively impact soil fertility in the long run. The purpose of this study was to analyze the effect of fertilizer combinations on the growth and yield of Nutri Zinc and Inpari 32 varieties in rainfed fields. By examining the optimal fertilizer combinations for Nutri Zinc and Inpari 32 varieties in rainfed paddy conditions, it is hoped that this research can provide appropriate recommendations for farmers to increase rice

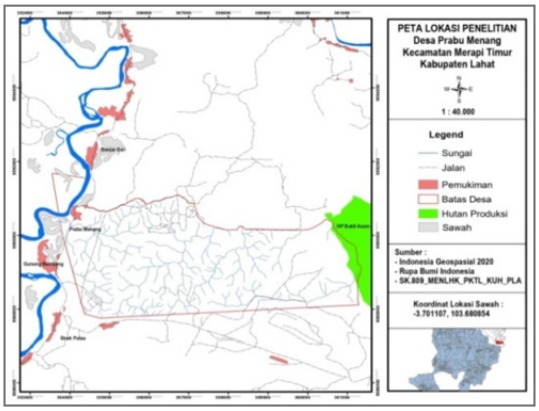

Figure 1. Location Map of Rice Fields in Prabu Menang Village

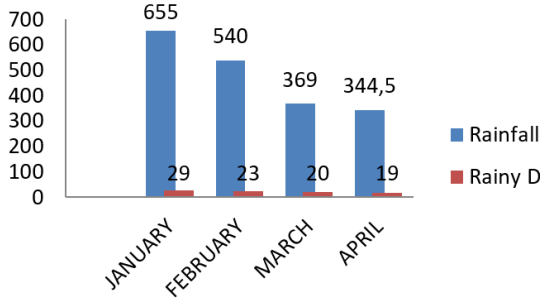

Figure 2. Monthly rainfall and rainy day data for the period January-April 2024

production.

2. MATERIAL AND METHODS

This research was conducted in RRF owned by the Subur Makmur farmer group, Prabu Menang Village, East Merapi District, Lahat Regency from January to April 2024. research location Thegeographically has a representative rainfed rice field condition for this research. The research area is also shown in Figure 1, which provides a visual representation of the geographical scope of the research.

The equipment used included meters, tarpaulins, sample stakes, analytical and digital scales, rulers, and cultivation tools (sickle, hoe, scratch tool, and sprayer). The materials used in this study were Inpari Nutri Zinc seeds, Inpari 32 seeds, NPK 16-16-16 Mutiara, Urea fertilizer, LOF (Liquid Organic Fertilizer) (Pucamadu brand). This research is a quantitative research using split-plot design with 6 treatment combinations and 4 replications so that there are 24 units experimental. The varieties used are Nutri Zinc and Inpari 32. The fertilizers used are NPK fertilizer (300 kg/ha), Urea fertilizer (150 kg/ha), and LOF given every 7 days after planting until the release of panicles on rice plants. The LOF application was done by spraying on the leaves at a dose of 25 mL/L for 8 times. The research began with clearing the land from weeds then the land was processed by plowing using a tractor. Seeds were soaked in drained water for 24 hours, then and allowed to stand for 48 hours germination. The nursery is carried out outside the cultivation area, with beds measuring 1-1.2 meters wide (Asis et al., 2021). The 21-day-old seedlings were transferred to the field with a spacing of 25x25 cm. Each hole was planted with 5 seedlings 5 cm deep. The distance between plot was 0.5 meters and between replications was 1 meter (Ikhwani et al., 2013). The NPK (300 kg/ha) was applied a week before planting and at the age of 7 DAT (Day After Tranplanting). Urea (150 kg/ha) was applied at 7, 21, and 42 DAT. Harvesting was done when 90- 95% of the grain was physiologically mature using a sickle, by cutting the bottom of the rice plant. The variable of characteristics plant height (cm), number of tillers (stems), panicle length (cm), productivity of milled dry grain yield (tons/ha). Analysis of variance (ANOVA) with α = 1% and α = 5% was used to assess data obtained from observations. To perform honest real difference test (HSD) using STAR software.

3. RESULTS AND DISCUSSION

General Conditions of Agricultural Practices

This research was conducted on RRF with rainfall in the period January to April 2024 was 1,908.5 mm with an average of 477.125 mm month^{-1}.

The highest rainfall is in January which is 655 mm with 29 rainy days and the highest rainfall is on day 13 which is 104.5 mm. The lowest rainfall is in April which is 344.5 mm with 19 rainy days and the highest rainfall is on day 27 which is 72 mm. Based on the results of the study it is known that the average rainfall in this study was 477.1 mm month^{-1}. Good rainfall for rice plants is above 200 mm month^{-1} (Nafisha and Suwarsito, 2018). Mubaroq (2013), said that rice plants require an average rainfall of 200 mm month^{-1} or more distributed for 4 months to be able to grow optimally. This condition shows that the rainfall in this study is relatively high. Especially in of January which has 655 mm rainfall. This caused the rice plants in this study to experience inundation stress conditions. According to Prasetyo and Setyorini (2008), inundation can result in changes in the chemistry of soil paddy namely a decrease in oxygen levels in the soil, reduction of iron (Fe) and manganese (Mn), a decrease in potential redox and changes in soil pH. This is in line with research Agus et al. (2004) which states that changes in the morphological properties of paddy fields continue to occur, especially in the upper layers, due to changes in soil physical and chemical properties. However, research shows that rice plants still grow well based on the plant conditions in the field.

Variance analysis of IR Nutri Zinc and Inpari 32 rice varieties

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The results of variance analysis showed that fertilizer type treatment gave a significant effect ($p < 0.01$) on the number of tillers and significantly different ($p < 0.05$) on the character of plant height. Meanwhile, the character of panicle length did not have a significant effect. The treatment of varieties has a real effect ($p < 0.05$) on the character of panicle length while the character of plant height has no real effect. This is in line with the research of Gusmiatun et al. (2022) which says that some varieties of rice plants have no significant effect on the growth and production of rice plants in landswamp . The results showed that varieties did not significantly affect all characters except for the variable panicle length.

Table 1. Effect of fertilizer type and variety on agronomic characters

Variables	Average	Fertilizer		Varieties	
		MS	CV	MS	CV
height	108.58	57.79 *	2.37	88.17 ns	3.92
Panicle Length	24.19	0.89 ns	9.22	31.97 *	7.58
Number of tillers	18.88	254.6 **	8.67	18.38 ns	11.76

** significant effect at level α=0.01; * significant effect at level α=0.05; ns= no significant effect; MS = mean square; CV = coefficient of variation

Effect of treatments on agronomic characters

Based on the observation, it is known that the treatment of Inpari 32 varieties in the combination of NPK and Urea fertilizers has the highest average plant height of 111.5 cm. While the Nutri Zinc treatment in the combination of LOF fertilizer types has the lowest average plant height of 101.75 cm. Nutri Zinc treatment on the combination of NPK, Urea and LOF combination has the highest average panicle length of 26.63 cm while Inpari 32 treatment on the NPK, Urea and LOF fertilizers has the lowest average panicle length of 22.50 cm. The combination of Inpari 32 treatment in the NPK and Urea fertilizers has the highest average number of tillers, 24.75 tillers while the Nutri Zinc treatment in the combination of LOF fertilizers has the lowest average number of tillers, namely 12.25 tillers. Based on the observations made it known is that the treatment of Inpari 32 in the combination of NPK, Urea and LOF fertilizers has the highest yield value of 4.67 tons/ha. The that treatment has the lowest productivity value is the Nutri Zinc variety treatment in the combination of LOF fertilizer types with a value of 3.66 tons/ha.

Based on the HSD test, the treatment of fertilizer types in the combination of NPK and Urea which has the highest average of 111.25 cm is significantly different from the treatment of a combination of LOF fertilizer types which has the lowest average plant height of 105.88 cm. However, it is not significantly different from the treatment of a combination of NPK, Urea and LOF fertilizers which has an average plant height of 108.62 cm. Meanwhile, the treatment with a combination of NPK, Urea and LOF fertilizer types is not significantly different from the treatment with a combination of LOF fertilizer types. It is known that the treatment of a average combination of NPK and Urea fertilizers which has the highest number of tillers, namely 22.5 tillers, is namely significantly different from the treatment of of a average combination of LOF which fertilizers has an the lowest number of tillers, NPK, Urea 12.38 tillers and and is not significantly different from the treatment a average combination LOF fertilizers which of 21.75 tillers.

Effect of fertilizer type combination on agronomic characters in rainfed paddy fields

Fertilizer application must consider the type, dose and time of application based on the results of soil tests or analysis in the laboratory (Hartatik and Widowati, 2015). Balanced fertilizer application by combining inorganic and organic fertilizers as needed for plant growth is expected to provide optimal results. In addition to nitrogen fertilizer, inorganic fertilizer must be balanced with the addition of potassium, phosphate fertilizer, and other nutrients so as not to become a limiting factor for soil fertility. In addition to improving soil physical, chemical, and biological fertility, organic fertilizer is also needed to increase the effectiveness of nutrient uptake from inorganic fertilizers. The concept of providing balanced nutrients to rice plants is so that the optimal uptake of NPK nutrients can be used to determine the nutrient needs of plants.

The results of observations on productivity variables show that the productivity of Inpari 32 varieties with NPK, Urea and LOF fertilizer treatments is the highest at 4.67 tons/ha compared to NPK and Urea fertilizer treatments which are 4.60 tons/ha with the same variety. Inpari 32 productivity is higher than the Nutri zink variety because Inpari 32 gets support from the number of tillers more than other varieties. One of the factors that support the increase in grain yield is the component of plant yield. In the research of (Suparwoto and Waluyo, 2022), said the number of grain contents / panicles followed by a large number of productive tillers tends to provide higher yields. Then Rois et al. (2017), argue that grain yield can be influenced by effective planting time, the amount of fertilizer, application time and water availability. Planting Nutri Zinc rice varieties in rainfed paddy fields aims to obtain rice varieties that are able to adapt to the growing environment so as to produce quantity of rice plants.

The application of liquid organic fertilizer in the treatment was able to affect the ability of rice plants to produce grain and rice yields due to the content of macro and micro elements contained in the LOF. The LOF used in this study itself uses beneficial microorganisms such as *Bacillus sp*, and *Azospirilium sp*, nitrogen fixing materials and phosphate sol-

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Table 2. Effect of fertilizer type and variety on the characters of plant height, panicle length, number of tillers and productivity

Treatment	Plant Height (cm)	Panicle Length (cm)	Number of tillers (tillers)	Yield (tons/ha)
NPK+Urea, Inpari 32	111.50	22.98	24.75	4,60
NPK+Urea, Nutri Zinc	111.00	25.18	20.25	4,35
NPK+Urea+LOF, Inpari 32	110.00	22.50	22.00	4.67
NPK+Urea+LOF, Nutri Zinc	107.25	26.63	21.50	4,41
LOF, Inpari 32	110.00	23.63	12.50	3.92
LOF, Nutri Zinc	101.75	24.23	12.25	3.66

Table 3. Effect of fertilizer type on the characters of plant height and number of tillers

Fertilizer	Plant Height (cm)	Number of tillers (tillers)
NPK+Urea	111.25 a	22.50 a
NPK+Urea+LOF	108.62 ab	21.75 a
LOF	105.88 b	12.38 b
HSD 5%	3.94	2,51

Numbers followed by the same letter in the same column are not significantly different based on the HSD (Honest Significant Difference) test at the 5% level.

vents. With these bacteria, nitrogen fixed by *Azospirilium* will be converted into available N and absorbed by plant roots, these bacteria also produce growth hormones in the form of auxins, cytokinins, and gibberellins so as to maximize inorganic fertilizers and optimal productivity. The phosphate solvents contained in LOF function to break down soil P and fertilizer sources, especially the bacterial secretion system in the form of organic acids. Organic acids secreted by bacteria increase and form calcium chelates with these organic acids ($AlPO_4$, $FePO_4$, and $Ca(PO_4)_2$). The P dissolves, thus increasing the amount of P in the soil to be absorbed by plants (Marlina et al., 2024). The use of organic fertilizers can increase soil microorganisms that can help increase the availability of soil microelements such as zinc, iron, copper, and others (Rehman et al., 2025).

This study used NPK Mutiara 16-16-16 fertilizer which contains complete and balanced N, P, and K to ensure uniform distribution of all nutrients for maximum plant growth and yield. This fertilizer also contains the best combination of Nitrate Nitrogen (NO_3), which is immediately available to plants, This fertilizer also contains Ammonium-Nitrogen (NH_4). which is slowly available as a reserve. The combination of organic and inorganic fertilizers can increase the growth of stem diameter, leaf length and width. The combination of these two types of Nitrogen gives a faster plant growth response and more yield. Acording to Siregar et al. (2023), the application of organic fertilizers with anorganic fertilizers can not only save the use of anorganic fertilizers, prevent nutrient imbalance, but also reduce the risk of environmental pollution, improve soil fertility, and increase rice yield. The synthesis of carbohydrates, proteins, lipids and other organic substances requires nitrogen (N), which is also an important component of chlorophyll, which gives leaves their green color. Energy transfer in plant cells is facilitated by phosphorus (P), which also promotes early fertilization and root development, strengthens stems against collapse, and increases uptake in early growth Pangalila et al. (2023).

Based on the observations, it can be seen that the panicle length of Nutri Zinc variety is longer than that of Inpari 32 variety. The significant difference between the varieties is due to the influence of genetic factors in the varieties. According to the description of the variety, each variety has a different height that affects plant height (Abbas et al., 2015). The use of appropriate superior varieties is important for farmers to get increased production. These two superior varieties were released as genetic resources that can be an option for farmers to determine which varieties are suitable for planting in the Prabu Menang Village area because these two varieties are tolerant of environmental stresses both abiotic (rainwater inundation) and biotic (pest and disease attacks). In addition, the proper use of fertilizer must pay attention to the type, dose, time, and method of application to achieve optimal results (Mishra and Dash, 2014). Thus, although the Inpari 32 and Nutri Zinc varieties have high yield potential, proper fertilization is essential to support rice production.

4. CONCLUSION

Based on the results and discussion in this study, the following conclusions are obtained:

1. The combination treatment of fertilizer types has a significant effect on plant height and number of tillers.

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2. NPK 300 kg/ha, Urea 150 kg/ha, and LOF 25 mL/L fertilizer with Nutri zink variety gave higher panicle length than the other treatments is 26.63 cm.
3. Unreal interaction of NPK fertilizer 300 kg/ha, Urea 150 kg/ha and LOF 25 mL/L with Inpari 32 variety produced the highest of yield is 4.67 tons/ha.

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