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Effect of NPK Fertilizer Dosage and Planting System on Rice Growth in Benelan Lor Village, Kabat Subdistrict, Banyuwangi

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Abstract: The purpose of this study was to evaluate the effects of NPK fertilizer application and planting systems on the growth of rice (Oryza sativa L.). A factorial randomized block design (RBD) was employed with two factors: planting system (three levels) and NPK fertilizer dose (four levels). This resulted in 12 treatment combinations, each replicated three times, for a total of 36 experimental units. Data were analyzed using analysis of variance (ANOVA) appropriate for RBD, with Duncan's multiple range test (DMRT) applied to observational variables at α=0.05α=0.05 or α=0.01α=0.01. Analysis of variance revealed significant interactions between NPK fertilizer dose and planting system for plant height at 30 days after planting (DAP), plant height at 40 DAP, number of tillers at 40 DAP, wet plant weight, and wet root weight. The Jajar Legowo 2:1 planting system produced highly significant improvements in wet plant weight and wet root weight compared to other systems. Among NPK doses, the P3 treatment yielded the best overall effects on rice growth. The combination of Jajar Legowo 2:1 (S2) and P3 dose exhibited the superior performance across parameters.

Keywords: NPK fertilizer, planting system, rice, dosage

1. Introduction

Rice is the main food commodity for the people of Indonesia. Efforts to increase rice production continue to be carried out in order to meet the growing food demand. Rice is a food crop commodity that produces rice grains and plays an important role in Indonesia's economic life. Rice as a staple food is very difficult to replace with other staple ingredients such as corn, tubers, sago, and other carbohydrate sources. Therefore, the availability of rice becomes the main priority for the community in fulfilling carbohydrate intake needs that can provide satiety and serve as the primary source of carbohydrates that are easily converted into energy (Ministry of Agriculture of the Republic of Indonesia, 2019).

Based on the report from the Banyuwangi Statistics Agency (2025), it shows that there has been a decline in the rice harvest area, where in 2023 it reached approximately 8,977 hectares and decreased in 2024 to 8,304 hectares. As a result of the declining harvest area, rice production in Kabat District also decreased, where in 2023 rice production reached 57,068 tons, while in 2024 it dropped to 54,134 tons.

Although Indonesia is an agrarian country and has extensive rice fields, Indonesia still imports rice. The cause is insufficient domestic production. Currently, the problems that occur include several varieties that are not suitable for the environment, some varieties that are easily attacked by pests, and others that are incompatible with local environmental conditions (Prasetia et al., 2022).

One of the efforts to increase rice production is through the regulation of planting systems and the use of appropriate fertilizers. The rice field planting system that is currently widely used by farmers in Indonesia is the "jajar legowo" system. According to Misran (2014), the jajar legowo planting system is the practice of leaving one empty row after every two or more rows of plants and narrowing the spacing within the edge rows, so it is known as legowo 2:1 when one empty row is alternated with two rows of rice plants, and 4:1 when alternated with four rows of rice plants. The basic principle of the jajar legowo planting system is to position all rows of plant clumps at the edge (near the bunds) to take advantage of the border effect of rice plants. With more alleyways in the rice field plots, fuller and better-filled grains can be produced.

The quantity of rice yield, apart from being determined by the planting system, is also influenced by fertilization. Fertilization commonly used by farmers in rice cultivation involves inorganic fertilizers containing macro and micronutrients such as N, P, K, and S. Plants use macronutrients in larger quantities, while micronutrients are used in relatively smaller amounts (Sudirja et al., 2020). Most farmers believe that rice growth using inorganic fertilizers results in better quality, while a small portion of the local community assumes that using organic fertilizers is more beneficial because it can reduce production costs. The purpose of this study is to determine the effectiveness of NPK fertilizer application and planting systems on the growth of rice plants (*Oryza sativa L.*).

2. Materials and Methods

This study used a factorial Randomized Block Design (RBD) with two factors. The first factor was the planting system consisting of 3 levels, and the second factor was the dose of NPK fertilizer consisting of 4 levels. Thus, there were 12 treatment combinations and each was repeated 3 times, resulting in a total of 36 experimental units. This research was conducted on agricultural land in Benelan Lor Village, Kabat District, Banyuwangi Regency, with an area of 0.25 Ha. The study was carried out for 3 months, from September to November 2024.

The land was prepared in advance according to the area required for the study. All vegetation on the land was removed, and the area was cleaned using hoes and cutting tools. Land cultivation was carried out twice using hoes. The hoe was used to create plots, and the soil was then placed into containers for planting. The research plots were established after soil cultivation. Each plot was made with a length of 100 cm and a width of 100 cm, consisting of 5 subplots, with a distance of 100 cm between plots and 3 replications.

The seeds were first soaked in water for 24 hours and incubated for 48 hours. The seeds were then directly sown in nursery media using used plastic cups filled with soil that had been turned into mud to resemble their natural growing conditions. Seedlings were transplanted at approximately 21 days of age using one seedling per planting hole, with treatments of several rice varieties and different fertilizer doses under moist muddy conditions.

Weeding was carried out at 20 days after planting (DAP) if weeds were present in the planting area. Weeding was done manually by uprooting weeds completely and destroying them. If any rice plants failed to grow or died due to certain factors, replanting or gap filling was carried out using seedlings of the same variety, ensuring that the replacement seedlings had good growth so they could catch up with the others. Fertilizer application was conducted by spreading fertilizer around the rice plants according to the predetermined doses and application intervals based on the treatments.

Pests that attacked the rice plants in this study included goats, cattle, rats, and grasshoppers. Goats and cattle attacked rice plants at 8 weeks after planting (WAP). Rats attacked the plants when the rice began to produce panicles. These pests were controlled by installing nets around the research area. Grasshoppers attacked the plants at 6 WAP and were controlled using Decis 25EC insecticide at a concentration of 3 ml/L of water.

Plant height measurements were carried out using a measuring tape, starting from the standard marker to the tip of the highest leaf at 10, 20, 30, and 40 DAP. The number of tillers was counted for each clump in every plot at 10, 20, 30, and 40 DAP. Fresh weight measurement was conducted when the rice plants were 40 days old by first removing the soil from the roots, as the parameter measured was the fresh weight of the rice plants. The fresh weight of the plants was measured using a scale and expressed in grams. Root fresh weight was measured after harvest by separating the roots from the upper parts of the plant, and weighing was conducted while the roots were still fresh.

Analysis of the observed variables was performed using ANOVA (Analysis of Variance) at a 5% significance level, and if the treatments showed a significant effect, further analysis was conducted using Duncan's Multiple Range Test (DMRT) at α = 5% or α = 1%.

3. Results and Discussion

The results of the analysis of variance in the study entitled *Effect of NPK Fertilizer Dosage and Planting System on Rice Growth in Benelan Lor Village, Kabat District* showed that there was an interaction between NPK fertilizer dosage and planting system on the parameters of plant height at 30 days after planting (DAP), plant height at 40 DAP, number of tillers at 40 DAP, plant fresh weight, and root fresh weight. A summary of the analysis of variance for all observation parameters is presented in Table 1 below:

Table 1. Summary of F-Calculated Values on the Effect of NPK Fertilizer Dosage and Planting System on Rice Growth in Benelan Lor Village, Kabat District

No	Observation Parameters	Planting System (S)	NPK Fertilizer Dose (P)	Interaction (S × P)
1.	Plant Height 10 DAP (cm)	7.47**	1.64ns	1.31ns
2.	Plant Height 20 DAP (cm)	13.06**	10.84**	1.71ns
3.	Plant Height 30 DAP (cm)	4.97*	4.80*	2.90*
4.	Plant Height 40 DAP (cm)	36.82**	26.24**	2.64*
5.	Number of Tillers per Clump 10 DAP (tillers)	4.30*	2.99ns	1.28ns
6.	Number of Tillers per Clump 20 DAP (tillers)	2.21ns	9.10ns	0.82ns
7.	Number of Tillers per Clump 30 DAP (tillers)	3.48*	12.22**	1.25ns
8.	Number of Tillers per Clump 40 DAP (tillers)	26.92**	28.67**	2.98*
9.	Plant Fresh Weight (grams)	29.68**	24.68**	2.88*
10.	Root Fresh Weight (grams)	33.67**	25.80**	3.39*

Notes:
ns = not significant;
*= significant at α 5%;
** = significant at α 1%.

Based on Table 1, the results showed that the NPK fertilizer dosage treatment had a significantly different effect on the parameters of plant height at 30 DAP, number of tillers per clump at 10 DAP, and number of tillers per clump at 30 DAP, and had a highly significant effect on the parameters of plant height at 20 DAP, plant height at 40 DAP, number of tillers per clump at 40 DAP, plant fresh weight, and root fresh weight. The NPK fertilizer dosage treatment also showed a significantly different effect on plant height at 30 DAP, and a highly significant effect on plant height at 20 DAP, plant height at 40 DAP, number of tillers per clump at 30 DAP, number of tillers per clump at 40 DAP, plant fresh weight, and root fresh weight.

Plant Height

Plant height is closely related to sunlight interception and nutrient uptake by plants. The greater the amount of light and nutrients received, the more energy is available for the photosynthesis process. Consequently, more photosynthates will be produced, which will later affect other growth parameters. Based on the analysis of variance presented in Table 1, the interaction between NPK fertilizer dosage and planting system showed a significantly different effect on plant height at 30 DAP and 40 DAP. The jajar legowo system is a planting system in which rice productivity can be increased by up to 15%. This system involves alternating the planting of rice in two or more rows with one empty row. The system also provides open space of about 25–50% at the edge rows, allowing better air circulation and more efficient utilization of sunlight needed for the photosynthesis process (Fadhillah et al., 2021). The interaction between NPK fertilizer dosage and planting system therefore significantly affected plant height at 30 and 40 DAP.

Number of Tillers per Clump

The number of tillers is a genetic trait and plays an important role in determining the productivity of lowland rice. Plants with the ability to produce a higher number of tillers are predicted to have higher productivity compared to those with fewer tillers. This must be supported by growth factors such as the use of an appropriate planting system and adequate nutrient supply that meets plant requirements (Windiyani et al., 2021). The application of NPK (inorganic) fertilizer is more readily available compared to organic fertilizer, which is slow release, so it can be directly absorbed by plants and influence plant growth (Shanti & Nirmala, 2020). The planting system showed a highly significant effect on the parameter of number of tillers per clump at 40 DAP, and a significant effect at 10 DAP and 30 DAP. The NPK fertilizer dosage treatment showed a highly significant effect on the number of tillers per clump at 30 DAP and 40 DAP. The interaction between planting system and NPK fertilizer dosage also had a significantly different effect on the number of tillers per clump at 40 DAP.

Plant Fresh Weight

Plant fresh weight represents the total weight of the plant obtained from metabolic activities during its life cycle. Fresh weight also reflects the overall biomass of the plant canopy. One of the requirements for optimal photosynthesis is sufficient water availability absorbed by plant roots. The parameter of plant fresh weight was measured directly by weighing after cleaning soil residues attached to the roots (Yulina et al., 2021). Plant fresh weight can also be considered as an indicator of the plant's ability to produce biomass. With the application of NPK fertilizer and the use of an appropriate planting system, nutrients such as nitrogen, phosphorus, and potassium can enhance protoplasm formation and cell wall materials, leading to increased cell size with thinner cell walls, causing cells to contain more water, which ultimately affects plant fresh weight (Meliawati et al., 2023). The treatments of planting system and NPK fertilizer dosage showed significantly different effects on plant fresh weight, while the single treatments of planting system and NPK fertilizer dosage each showed highly significant effects.

Root Fresh Weight

Roots are plant organs that are equally important as other parts and are directly responsible for the absorption of water and nutrients dissolved in soil solution. Roots function as plant support to enable upright growth and to absorb nutrients and water required for metabolic processes (Kurniasih et al., 2020). The jajar legowo planting system provides wider growing space while maintaining higher plant population. This system improves air circulation and sunlight utilization in the field. The rate of nutrient uptake by plant roots tends to increase with higher intensity of absorbed sunlight. Root fresh weight is related to nutrient absorption by plants, as more roots will increase root fresh weight. With adequate nutrient supply according to plant needs, roots will grow

optimally and plant growth will be maximized (Misran, 2014). The treatments of planting system and NPK fertilizer dosage showed significantly different effects on root fresh weight, while the single treatments of planting system and NPK fertilizer dosage each showed highly significant effects.

4. Conclusions

Based on the results of the research that has been conducted, two conclusions can be drawn:

1. The planting system showed a highly significant difference, in which the Jajar Legowo 2:1 system resulted in an increase in plant growth, particularly in plant fresh weight and root fresh weight.
2. The NPK fertilizer dosage showed a highly significant difference, with treatment P3 providing the best effect on rice plant growth. An interaction occurred between the planting system and NPK fertilizer dosage, where the combination of S2P3 showed the best overall results.

5. Patents

Further research is recommended on the effect of the jajar legowo planting system and NPK fertilizer dosage by adding production-related observation variables, such as wet grain weight, dry grain weight, and yield per hectare, in order to obtain more comprehensive and accurate results.

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