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Rice Booster Application to Enhance Rice Growth and Productivity

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ABSTRAK

Pemupukan berperan penting dalam praktik pertanian dengan mengoptimalkan kesuburan tanah dan hasil produksi. Namun, penelitian mengenai penambahan kalium melalui aplikasi daun pada tanaman padi masih terbatas. Penelitian ini bertujuan untuk mengevaluasi pengaruh penambahan pupuk kalium melalui aplikasi daun terhadap pertumbuhan dan hasil padi. Penelitian disusun menggunakan Rancangan Acak Kelompok Lengkap dengan enam perlakuan dan empat ulangan. Perlakuan terdiri atas enam taraf dosis pemupukan rice booster: kontrol (P0), 0.5 (P1), 0.75 (P2), 1.0 (P3), 1.25 (P4), dan 1.5 (P5). Seluruh perlakuan diberikan pemupukan dasar berupa 300 kg NPK 15-15-15 dan 100 kg urea per hektar. Hasil penelitian menunjukkan bahwa aplikasi 1.0 hingga 1.5 kali dosis anjuran mampu meningkatkan pertumbuhan tanaman, sedangkan dosis 1.25 hingga 1.5 menghasilkan gabah kering panen dan gabah kering giling yang lebih tinggi. Dosis 1.25 terbukti efektif secara agronomis dan lebih menguntungkan secara ekonomi.

Kata Kunci: Aplikasi daun, Hara makro, Hara tambahan, Produktivitas

ABSTRACT

Fertilization plays a crucial role in agricultural practices by optimizing soil fertility and yields. However, research on potassium supplementation through foliar application to rice crops is still limited. This study aimed to evaluate the effect of potassium supplementation through foliar application on rice growth and yield. The study was arranged using a Randomized Complete Block Design with six treatments and four replications. The treatments consisted of six levels of rice booster dosage: control (P0), 0.5 (P1), 0.75 (P2), 1.0 (P3), 1.25(P4), and 1.5 (P5) doses. All treatments were given basal fertilization in the form of 300 kg NPK 15-15-15 and 100 kg of urea per hectare. The results showed that application of 1.0 to 1.5 of the recommended dosage increased plant growth, while dosages of 1.25 to 1.5 resulted in higher yields of harvested dry grain and milled dry grain. The 1.25 dosage proved agronomically effective and more economically profitable.

Keywords: *Foliar spray, Macro nutrient, Supplement nutrient, Productivity*

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Introduction

Fertilization plays a crucial role in agricultural practices, optimizing plant productivity by enhancing soil fertility. The principal objective of fertilization is to provide essential nutrients, including macronutrients such as nitrogen, phosphorus, and potassium, as well as micronutrients, in quantities sufficient to support healthy plant growth (Sharif et al., 2023). Fertilizers replenish nutrients that plants extract during their growth; however, they may also disrupt the nutrient dynamics within the soil. For instance, the use of nitrogenous fertilizers can increase the availability of nitrogen, potentially inhibiting the synthesis of certain plant secondary metabolites, ultimately affecting the quality and stress resilience of crops (Wu et al., 2021).

The use of inorganic fertilizers serves as a crucial method for improving soil macronutrient composition, which is particularly important for the growth of crop plants, including rice. Inorganic fertilizers can be categorized into single fertilizers, which supply a single nutrient, and compound fertilizers, which provide multiple nutrients simultaneously. Among these, nitrogen (N), phosphorus (P), and potassium (K) are the primary macronutrients essential for plant development and are particularly pivotal for rice cultivation (Jiang et al., 2018). Nitrogen is vital during the vegetative phase of rice plants, as it promotes growth and enhances leaf greenness through its role in chlorophyll synthesis (Panthi et al., 2019). Potassium is another critical macronutrient that plays multiple roles in promoting flowering and fruit formation. It improves plant sturdiness and stimulates root growth, while also participating in various physiological processes, including enzyme activation and regulation of stomatal movements, which collectively contribute to improved water use efficiency (Mahmood et al., 2017; Jiang et al., 2018; Kuntyastuti et al., 2019).

The role of potassium (K) during the vegetative growth phase to the flowering stage in lowland rice is critical, as a sufficient K supply is essential for optimal growth and yield. Previous research suggests that when leaf potassium concentration ranges from 1.8% to 2.6%, additional K application may not yield significant benefits in terms of growth response or grain yield (Deng et al., 2023). However, the application of K fertilizer is known to markedly enhance grain yield. For instance, a notable increase in rice grain yield has been reported with the application of K fertilizers, such as a 12% increase with the application of 33 kg K/ha in certain studies (Chairuman et al., 2023). However, soil-applied K is sometimes inefficient due to fixation, leaching, or limited mobility (Liu et al., 2025).

However, research on the addition of potassium (K) through foliar application remains limited, particularly in rice plants. It is hypothesized that K applied via foliar feeding may be absorbed more rapidly by the plants. Additionally, foliar absorption is suspected to enhance rice yield. Therefore, further studies are needed to verify this hypothesis. Consequently, the objective of this study is to determine the growth response and yield of rice plants when supplemented with K through foliar application as an additional fertilizer.

Methodology

Study sites and species sampling

The experiment took place at the IPB Sawah Baru research farm in Dramaga, Bogor. It was carried out over a four-month span, from September through December 2015. The site sits at an elevation of 192 meters above sea level and receives an average monthly rainfall of about 324 mm.

The materials used in this study included Ciherang rice variety seeds, rice booster liquid fertilizer (which contains nitrogen (N) at 13.08% and potassium oxide (K_2O) at 44.28%), urea fertilizer, SP-36, and KCl. The equipment utilized consisted of a hoe, hand cultivator, sprayer, sample stakes, measuring tape, and digital scale. Data processing was conducted using a computer and the SAS statistical analysis software.

Experimental design

The study employed a randomized complete block design (RCBD) with four replications. Six levels of rice booster fertilization were tested: no application (P0), 0.5 dose (P1), 0.75 dose (P2), 1.0 dose (P3), 1.25 doses (P4), and 1.5 doses (P5). One full dose corresponded to 2 kg per hectare per application, prepared at a concentration of 4 g per liter of water (Fakharzadeh et al., 2020). The spraying volume was 500 liters per hectare. All plots received a basal fertilizer treatment of 300 kg NPK (15-15-15) and 100 kg urea per hectare. With four replications, the experiment comprised 24 plots, each measuring 25 m².

Research procedures

The land was prepared using a tractor until it reached a fully saturated, muddy condition. Initially, plowing was conducted, followed by harrowing and land leveling two weeks later. The field was then divided into plots measuring 5 m × 5 m, each equipped with an inlet and drainage channel. The treatments were randomized within replications (blocks), with efforts made to ensure homogeneous conditions across blocks.

The basal fertilizer was administered via a top-dressing approach. The NPK 15-15-15 fertilizer was applied in two phases: half of the total dosage was given one week after planting, and the subsequent half was applied at four weeks after planting. The full dose of urea fertilizer was applied at one WAP. Rice booster fertilizer was delivered to the plant canopy through foliar spraying at three, five, and seven WAP. Measures for pest and disease management were executed according to infestation levels, while weed control was performed at two and six WAP. Harvesting occurred 30–35 days following flowering, identified by 90–95% of the rice grains exhibiting a yellow hue, indicating their maturity.

Weekly observations of plant growth metrics, including height and the number of tillers, were conducted from the third to the sixth week after planting. For these assessments, five plants were chosen at random from each experimental plot. The determination of yield and its constituent elements involved evaluating parameters such as panicle length, the quantity of grains per panicle, the mass of 1,000 grains, the count of productive tillers, the grain output per plant, the wet and dry grain yields per unit area, and the dry and milled dry grain yields per hectare, all derived from data collected at the plot level.

Data analysis techniques

The collected data were subjected to statistical analysis using ANOVA. In instances where significant differences were identified, the treatment means were compared using Duncan's Multiple Range Test, set at a 5% level of significance.

Results and discussion

The effect of rice booster application on the growth of lowland rice

The application of rice booster fertilizer had a significant effect on the plant height of lowland rice three weeks after planting. The application of 1.0, 1.25, and 1.5 doses of rice booster resulted in greater plant height compared to the control at three WAP (Table 1). However, the rice booster application did not show significant differences among treatments at six WAP.

The application of rice booster fertilizer also had a significant effect on the number of tillers from three to six weeks after planting. The application of 1.0, 1.25, and 1.5 doses of rice booster resulted in a higher number of tillers at three and five WAP compared to the control. Additionally, the application of 1.25 and 1.5 doses resulted in a greater number of tillers at four and six WAP compared to the control (Table 2). The application of 1.25 and 1.5 doses of rice booster showed a consistent trend, with a higher number of tillers than the control up to six WAP.

The application of potassium fertilizer via foliar methods has been shown to positively affect the growth of rice plants, particularly by increasing the number of tillers. Research by Mahmoodi et al. (2020) reported a significant improvement in various agronomic characteristics of rice, such as plant height and tiller count, due to the foliar application of liquid fertilizers. These findings are consistent with other studies that suggest the foliar delivery of macro- and micronutrients during critical growth stages like transplanting, tillering, and panicle initiation can considerably influence tiller development. Furthermore, Vijayakumar et al. (2019) demonstrated that potassium fertilization notably enhanced growth parameters, including tiller production, in dry direct-seeded basmati rice. Similarly, Zhang et al. (2023) emphasized that effective foliar nutrient application can stimulate tiller formation and improve the structural integrity of rice plants, which is crucial for maximizing yield under diverse stress conditions.

Table 1. Effect of Rice Booster Fertilizer Application on the Plant Height of Lowland Rice

Treatment	Plant Height (cm)			
	3 WAP	4 WAP	5 WAP	6 WAP
Control	42.8d	50.6ab	62.8abc	75.7a
0.5 dosage of rice booster	43.3d	49.4b	59.3bc	73.6a
0.75 dosage of rice booster	43.9cd	50.7ab	59.2c	74.9a
1.0 dosage of rice booster	51.5a	57.0a	67.5a	84.5a
1.25 dosage of rice booster	49.3ab	55.7ab	65.9ab	83.9a
1.5 dosage of rice booster	48.7abc	53.9ab	65.9ab	79.6a

Note: Numbers within the same column followed by the same letter indicate no significant difference based on Duncan's Multiple Range Test (DMRT) at the 5% significance level.

Table 2. Effect of Rice Booster Fertilizer Application on the Tillers Number of Lowland Rice

Treatment	Tillers Number			
	3 WAP	4 WAP	5 WAP	6 WAP
Control	8.2b	11.9c	12.1d	17.4cd
0.5 dosage of rice booster	9.2b	13.1c	13.5d	16.9d
0.75 dosage of rice booster	9.7b	12.5c	14.7cd	17.7cd
1.0 dosage of rice booster	12.0a	15.0abc	17.7abc	18.9bc
1.25 dosage of rice booster	13.0a	16.0ab	19.5a	19.7ab
1.5 dosage of rice booster	12.1a	17.2a	18.9ab	21.2a

Note: Numbers within the same column followed by the same letter indicate no significant difference based on Duncan's Multiple Range Test (DMRT) at the 5% significance level.

Table 3. Effect of Rice Booster Fertilizer Application on the Yield Component of Lowland Rice

Treatment	Productive Tiller Number	Panicle Length (cm)	Number of Grains/Panicle	1000-grain Weight (g)
Control	17.4a	26.7a	195.3a	26a
0.5 dosage of rice booster	18.4a	26.7a	190.7a	26a
0.75 dosage of rice booster	19.9a	27.4a	206.7a	26a
1.0 dosage of rice booster	17.5a	26.7a	183.4a	25a
1.25 dosage of rice booster	17.9a	27.0a	200.5a	26a
1.5 dosage of rice booster	21.6a	27.1a	176.1a	27a

Note: Numbers within the same column followed by the same letter indicate no significant difference based on Duncan's Multiple Range Test (DMRT) at the 5% significance level.

Influence of rice booster application on yiled attributes and grain output in lowland rice

No statistically significant effects were observed from the rice booster application concerning the number of productive tillers, panicle length, the quantity of grains per panicle, or the 1000-grain weight. Different rice booster fertilizer dosage treatments yielded productive tiller numbers, ranging from 17.4 to 21.6 tillers per clump. Additionally, the application of rice booster fertilizer yielded panicle lengths, grain numbers per panicle, and 1000-grain weights ranging from 26.7 to 27.4 cm, 176.1 to 206.7 grains, and 25 to 27 g, respectively (Table 3).

The application of the rice booster, conversely, demonstrated a notable influence on both plot yield and yield per hectare when compared to the control group, yet it did not statistically alter the yield per plant (Table 4). The application of 1.25 times the recommended rice booster dose resulted in a higher fresh plot yield than the control. Furthermore, both the 1.25 and 1.5 times dosage treatments produced higher dry plot yields compared to the control. The 1.25 dose treatment also yielded a higher harvest per hectare of dry grain compared to the control, while both the 1.25 and 1.5 dose treatments resulted in higher milled dry grain yields than the control treatment.

Table 4. Effect of Rice Booster Fertilizer Application on the Yield of Lowland Rice

Treatment	Yield/Plant (g)		Plot Yield (kg)		Yield/ha (kg/ha)	
	Wet Grain	Dry Grain	Wet Grain	Dry Grain	Dry Grain	Milled Dry Grain
Control	62a	50.3a	5.2b	4.5c	8053b	7147c
0.5 dosage of rice booster	62a	50.1a	5.1ab	4.6bc	8213ab	7307bc
0.75 dosage of rice booster	61a	48.7a	5.7ab	5.1abc	9067ab	8107abc
1.0 dosage of rice booster	55a	43.5a	6.3ab	5.6abc	10133ab	9013abc
1.25 dosage of rice booster	54a	43.4a	6.4a	5.9a	10240a	9387a
1.5 dosage of rice booster	67a	54.4a	6.3ab	5.7ab	10027ab	9120ab

Note: Numbers within the same column followed by the same letter indicate no significant difference based on Duncan's Multiple Range Test (DMRT) at the 5% significance level.

Table 5. Farm Business Analysis Results for Various Rice Booster Fertilizer Treatments

Treatment	Cost (Rp)	Revenue (Rp)	Profit (Rp)	R/C Ratio
Control	13 275 000	32 212 000	18 937 000	2.43
0.5 dosage of rice booster	13 545 000	32 852 000	19 307 000	2.43
0.75 dosage of rice booster	13 680 000	36 268 000	22 588 000	2.65
1.0 dosage of rice booster	13 815 000	40 532 000	26 717 000	2.93
1.25 dosage of rice booster	13 950 000	40 960 000	27 010 000	2.94
1.5 dosage of rice booster	14 085 000	40 108 000	26 023 000	2.85

The nitrogen and potassium present in rice booster fertilizer contribute to increased productivity in rice plants. Nitrogen assimilation by plants occurs as ammonium in anaerobic environments and as nitrate in aerobic conditions (Beier et al., 2019). It is then translocated to the leaves, serving as a vital source for photosynthesis (Luo et al., 2022; Li et al., 2018; Li et al., 2024). For instance, studies have shown that rice plants exhibit increased nitrogen use efficiency and improved grain yield when nitrogen is supplied optimally, highlighting the importance of nitrogen not just in uptake but also in the physiological processes that lead to successful photosynthesis (Miyoshi et al., 2023; Xing et al., 2022). Meanwhile, the potassium in rice booster plays a crucial role in enhancing the photosynthesis process, optimizing water usage, and facilitating the transformation and translocation of metabolic products within the plant from one part to another (Chen et al., 2015; Chairuman et al., 2023).

Farm business analysis

The economic effectiveness of rice booster fertilizer was evaluated based on profit and the benefit-cost (B/C) ratio for each treatment (Table 5). These two indicators were used to assess the economic feasibility of the farming practice. All rice booster fertilizer dosage treatments were economically viable, as they yielded positive profits and benefit-cost ratios (B/C ratios) greater than 1. The application of 1.25 times the recommended dose of rice booster resulted in the highest B/C ratio, approximately 2.94, whereas the control treatment produced a B/C ratio of only 2.43.

Discussion

Efficient potassium management plays a pivotal role in promoting starch translocation from leaves to developing grains, a key process for enhancing grain filling and increasing the number of well-filled grains per panicle (Bhatt et al., 2024). This improvement is further reinforced by evidence showing that potassium application accelerates the transfer of carbohydrates from vegetative tissues to reproductive organs, thereby boosting the harvest index (Paiman et al., 2021). In addition to its involvement in carbohydrate metabolism, potassium strengthens plant resilience against various stress factors, which helps reduce grain sterility and improve overall yield (Hossain et al., 2023). Optimal potassium availability also stimulates critical enzymatic activities that facilitate nutrient mobilization and photosynthate translocation within the plant, ultimately contributing to higher grain and straw yields (Sigdel et al., 2023).

Potassium application is widely recognized for enhancing water use efficiency, thereby alleviating drought stress and maintaining essential metabolic functions under less-than-ideal conditions (Swain et al., 2025). This benefit is particularly critical in aerobic rice systems, where sufficient potassium fertilization improves the adaptability and resilience of rice cultivars (Wakeel et al., 2017). Economic assessments further indicate that optimizing potassium supply can substantially increase net returns and benefit-cost ratios, making it a cost-effective input for farmers (Magare et al., 2018; Wakeel et al., 2017). For example, a 2% foliar potassium spray has been reported to yield a benefit-cost ratio of 1.24 under drought conditions, while soil-applied potassium achieved a ratio of 1.30 (Usman et al., 2025). In contrast, excessive application—such as 180 kg K_2O ha^{-1} in Super Basmati rice—has been associated with reduced net benefits and lower benefit-cost ratios, suggesting a saturation point or antagonistic effect at high doses (Wakeel et al., 2017). These findings underscore the need for precise potassium management, as over-application can lead to diminishing returns and even adverse economic outcomes, despite potassium's essential role in metabolic processes such as amino acid synthesis and nitrate assimilation (Singh et al., 2020).

CONCLUSION AND SUGGESTIONS

Conclusion

The results of the study indicated that, in general, applying 1.0 to 1.5 times the recommended dose of rice booster fertilizer resulted in better plant growth compared to the control treatment. Treatments with 1.25 to 1.5 doses produced higher yields of harvested dry grain and milled dry grain than the control. The application of 1.25 times the recommended dose was agronomically effective and economically more profitable compared to the control.

Suggestion

Future research should investigate the long-term effects of sustained rice booster application on soil health and microbial communities, as well as the potential for genetic variations in rice cultivars to influence responsiveness to varying booster concentrations. Furthermore, studies could explore the optimal timing and methods of application, such as foliar versus soil application, to maximize nutrient uptake and minimize environmental impact while maintaining economic viability.

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