

The Effect of Stem Cutting Time on the Growth and Yield of Lowland Rice on the Organic-Based SALIBU System

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Abstract

Innovation in organic-based rice cultivation technology is needed to overcome the food crisis. One method is the SALIBU (single planting, multiple harvests) system, which requires precise control of rice stem cutting height. This study aims to examine the growth and production of lowland rice in response to rice stem cutting height using the SALIBU method. Field research was conducted for six months (April–October 2024) in Taratara Dua Village, Tomohon City. The materials used included Inpari 32 rice seeds, straw compost, liquid organic fertiliser, and Phonska NPK fertiliser. This study used a Randomised Block Design (RBD) with four stem cutting time treatments: 0, 3, 6, and 9 days after harvest, each with three replications. Observed variables included plant height, number of productive tillers, number of full and empty grains per panicle, and harvest yield. The results showed that stem cutting time significantly affected plant height, number of productive tillers, number of full grains, and harvested dry grain yield (GKP). However, there was no significant effect on the number of empty grains. The most effective time for cutting stems is 0 days after harvest (at harvest time).

Keywords: organic base; lowland rice; stem cutting; SALIBU

INTRODUCTION

Rice (*Oryza sativa* L.) is a major food commodity in Indonesia and an important source of carbohydrates for the population. However, national rice production faces various challenges, including climate change and declining land productivity. Data from Badan Pusat Statistik (BPS) shows that in 2023, there was a 2.45% decrease in harvested area (to 10.20 million hectares) and a 2.05% decrease in rice production (to 53.63 million tons of dry milled grain/GKG) compared to 2022. This decline directly impacted the availability of rice for consumption, which also fell by 645,090 tons in 2023 (BPS, 2023).

Population growth and global climate change demand innovation in cultivation technology to maintain national food security. Rather than clearing new land, one effective strategy is to intensify cultivation on existing land. According to the Food and Agriculture Organisation (FAO), the modern concept of food security focuses not only on quantity but also on quality, safety, and the resilience of food systems to crises. Therefore, innovations are needed that can address all of these challenges simultaneously (FAO, 2021).

One promising technological innovation for increasing rice productivity is the SALIBU cultivation system, a modification of the ratoon cropping system. This system allows farmers to harvest rice repeatedly from a single planting, utilising the ability of the plant's rootstock to produce new shoots or tillers after harvest. The main advantage of the SALIBU system is substantial savings in production costs, particularly soil preparation, seeding, and planting, as well as reduced labour requirements. Furthermore, this system can accelerate harvest times, with a shorter cycle than the parent crop, and save on irrigation water use. The SALIBU (Sekali Tanam Panen Berulang Kali) cultivation innovation is a promising solution to address these issues. This method leverages the rice plant's ability to regenerate after the first harvest, allowing farmers to harvest again

without the need for replanting (Sari et al., 2022). This system not only has the potential to save production costs, such as seed and land preparation costs, but also shortens the harvest cycle, ultimately improving the cropping index (Agricultural Service, 2023).

The timing of stem cutting at the first harvest is a determining factor in the success of regeneration and the growth of new tillers. Optimally timed cutting can stimulate simultaneous new shoot growth, which then produces productive tillers and panicles containing quality grain (Prasetyo & Fitriani, 2022). Conversely, inappropriately timed cutting can inhibit regeneration, reduce the number of productive tillers, and decrease overall yields (Fauzi et al., 2023; Agus & Lestari, 2023). Furthermore, implementing the organic-based SALIBU system aligns with sustainable agriculture principles, reduces reliance on inorganic fertilisers, and improves long-term soil health (Nurhayati, 2022; Susanto, 2021). This research was conducted to overcome the limited information regarding the most efficient stem cutting time in the organic-based SALIBU system to achieve maximum crop yield.

This study aims to: (1) examine the effect of stem cutting time after harvest on the growth and yield of rice paddies using the organic-based SALIBU system, and (2) determine the optimal stem cutting time to increase the growth and yield of rice paddies using the organic-based SALIBU system. It is hoped that this study can provide accurate, practical guidelines to farmers regarding the most efficient stem cutting time for rice paddies in implementing the SALIBU system, and also provide valid scientific information regarding the response of rice paddy plants to stem cutting treatment in the organic-based SALIBU system as a basis for further research in the field of agronomy.

METHODS

Place and Time

Field research was conducted in Taratara Dua Village, West Tomohon District, Tomohon City, for four months, from May 2024 to September 2024.

Materials and Equipment

The materials and equipment used were: Mekongga rice seeds, straw compost, liquid organic fertilizer, Phonska NPK fertilizer, a lawn mower, an analytical balance, a measuring tape, and stationery.

Research Methods

The experimental design used was a Randomized Block Design (RBD). The treatments consisted of one factor, namely stem cutting time: 0, 3, 6, and 9 days, denoted by P0, P1, P2, and P3. Each treatment was replicated three times, resulting in 16 experimental plots.

Research Procedures

1. Preparation for the first planting season harvest: plot determination for SALIBU.
2. SALIBU Method: This is done by removing straw and weeds after harvest. The field is then irrigated to a depth of approximately 5 cm for 2-5 days. The goal is to maintain soil moisture, prevent the rice stalks from drying out, and suppress the growth of new tillers. This is done before pruning to ensure uniform rice plant growth. Plant maintenance includes: replanting, weeding, fertilization, and monitoring for plant pests and diseases (OPT).

Observed Variables

In this study, the response variables observed at harvest included:

1. Plant height
2. Number of productive tillers
3. Number of full grains per panicle
4. Number of empty grains per panicle
5. Harvested dry grain yield (measured after harvest)

Data Analysis

Data from all variables were analyzed using analysis of variance. If significant differences were found, the analysis was continued with the Least Significant Difference Test (LSD) at the 5% significance level.

RESULTS AND DISCUSSION

Statistical analysis shows that the timing of rice stalk cutting after harvest affects plant height, the number of productive tillers, the number of full grains per panicle, and yield per plot. The effect of rice stalk cutting timing is presented in **Table 1**.

Table 1. Effect of Rice Stem Cutting Timing on Plant Height, Number of Productive Tillers, Number of Full Grains per Panicle, Number of Empty Grains per Panicle, and Yield

Treatment	Plant Height (cm)	Number of Productive Tillers	Number of Full Grain per Panicle	Number of Empty Grain per Panicle	Yield per Plot
0 days (P0)	82.67 a	25.00 a	70.07 a	17.00 a	2.87 a
3 days (P1)	80.87 a	21.00 b	67.47 a	16.80 a	2.52 b
6 days (P2)	80.87 a	19.00 c	68.47 a	16.00 a	2.28 c
9 days(P3)	75.47 b	15.73 d	61.73 b	17.00 a	1.66 d
LSD 5%	4.52	1.26	3.03	2.95	0.14

Note: Numbers followed by the same letter do not have statistically significant differences at the 95% confidence level.

Plant Height

Statistical analysis showed that the timing of rice stalk cutting after harvest significantly affected plant height. The 0-day-old (P0) cutting treatment achieved the highest plant height, at 82.67 cm, followed by the 3-day-old (P1) and 6-day-old (P2) treatments, which each achieved a height of 80.87 cm. Meanwhile, the 9-day-old (P3) treatment showed the lowest plant height, at 75.47 cm. The Least Significant Difference (LSD) at the 5% level was 4.52, indicating a significant difference between the P0 and P3 treatments.

The results of this study indicate that the timing of rice stalk cutting plays a significant role in determining plant height. This finding aligns with research by Kurniawan et al. (2021), which states that optimal stalk cutting can increase plant height because the plant has sufficient time to utilise available resources. Cutting rice stalks at the right time, especially 0 days after harvest, has a positive impact on plant height growth, because it provides the best opportunity for plants to maximise photosynthesis and the growth process, thus supporting the achievement of more optimal plant height. In contrast, delaying cutting by 9 days caused a decrease in plant height, which may be due to plant stress due to delayed cutting and decreased growth quality.

Previous research by Santoso et al. (2020) supports these findings, indicating that

delaying stem cutting can lead to reduced plant height because the plant is unable to optimize the use of available energy and nutrients. They demonstrated that cutting rice stems immediately after harvest (at 0 days) is the most effective treatment for maximizing growth and yield. Delaying the cutting especially up to 9 days significantly inhibits growth, reduces the number of productive tillers, and drastically decreases yield. According to Gardner et al. (1985), cutting at this stage causes severe stress that hinders regeneration and growth. Pruning during the late vegetative growth phase can induce physiological stress in plants, as noted by Jones and Smith (2020). This stress diverts the plant's energy from vertical growth to wound healing and tissue regeneration, leading to a slowdown in growth and reduced plant height. In contrast, pruning conducted earlier in this phase such as on day 0 or day 3 enables plants to recover more swiftly without hindering their growth. This observation is further supported by Lambers et al. (2008), who indicated that young plants are more adaptable and can respond more effectively to rapid wound healing.

Number of Productive Tillers

The analysis results presented in **Table 1** show that the timing of rice stalk cutting after harvest significantly influenced the number of productive tillers. The treatment cutting at 0 days (P0) produced the highest number of productive tillers, at 25.00 tillers, followed by the treatment at 3 days (P1) with 21.00 tillers. Meanwhile, the treatments at 6 days (P2) and 9 days (P3) showed lower yields, at 19.00 and 15.73 tillers, respectively. The Least Significant Difference (LSD) value set at 5% was 1.26, indicating that the differences between treatments P0 and P1, as well as between P1 and P2, were significant. These results indicate that the timing of rice stalk cutting plays a crucial role in determining the number of productive tillers. Cutting at 0 days after harvest provides the best opportunity for the plant to maximise photosynthesis and nutrient accumulation, which supports the formation of more tillers. In contrast, delaying cutting by up to 9 days caused a decrease in the number of productive tillers, which may be due to a decrease in the quality of plant growth due to the delay in cutting. The findings are consistent with research by Sari et al. (2020), which indicates that properly timed stem pruning can enhance the number of productive tillers, as the plant can more effectively utilize available resources. Additionally, Lambers et al. (2008) observed a lasting negative impact of delayed stem pruning on tiller initiation. When pruning is postponed, the plant invests more energy in initial vegetative growth, thereby limiting the energy available for forming new tillers. This situation may also be linked to the increasing apical dominance that occurs as the plant ages, which restricts lateral shoot growth and the formation of productive tillers.

Previous research by Putra et al. (2021) supports the finding that delaying stem cutting can lead to a reduction in the number of productive tillers. This occurs because the plant is unable to optimize the use of the available energy and nutrients. Similarly, research by Brown and Miller (2019) demonstrates that performing stem cutting immediately after planting significantly increases the number of productive tillers, which is positively correlated with grain yield. Overall, these findings indicate that the earlier stem cutting is carried out, the more productive tillers the plant can produce. Conversely, delaying stem cutting gradually decreases the plant's potential to generate productive tillers, ultimately reducing yield (Gardner et al., 1985).

Number of Fully Grained Rice per Panicle

The analysis results presented in Table 1 indicate that the timing of rice stalk cutting after harvest significantly affected the number of full-grained rice per panicle. The treatment with cutting on day 0 (P0) resulted in the highest number of full-grained rice, with an average of 70.07 grains per panicle. This was followed by the treatments cut on day 3 (P1) and day 6 (P2), which yielded 67.47 and 68.47 grains per panicle, respectively. In contrast, the treatment cut on day 9 (P3) showed the lowest yield, averaging 61.73 grains per panicle. The Least Significant Difference (LSD) value, set at 5%, was 3.03, indicating that the difference in yield between treatment P3 and the other treatments was statistically significant.

The results of this study indicate that cutting rice stalks at the optimal time, specifically at 0 days after harvest, positively impacts the number of full grains produced. This finding aligns with research by Zhang et al. (2022), which suggests that timely cutting increases nutrient and energy accumulation in grain, leading to a higher number of full grains. Cutting at 0 days after harvest allows the plants to maximize photosynthesis and nutrient uptake, thereby enhancing the formation of full grains. Conversely, delaying the cutting for up to 9 days results in a decrease in the number of full grains, likely due to nutrient loss and reduced grain quality. Supporting these findings, Nuzul et al. (2018) reported that the highest yield components and overall yield of ratoon rice were achieved when cutting was performed at harvest at a height of 3 cm above the soil surface, yielding 3.54 tons per hectare. Additionally, research by Jones and Smith (2020) discovered that stress in plants, particularly during the grain formation phase, can interfere with photosynthesis and the translocation of sugars from leaves to grains. This disruption can lead to incomplete grain filling, resulting in fewer full grains per panicle and a reduced overall yield.

Number of Empty Grains per Panicle

The analysis results presented in **Table 1** indicate that the timing of rice stalk cutting after harvest did not significantly impact the number of empty grains per panicle. Specifically, the data reveal that treatments at 0 days (P0) and 9 days (P3) each resulted in 17.00 empty grains, while treatments at 3 days (P1) and 6 days (P2) yielded 16.80 and 16.00 empty grains per panicle, respectively. This suggests that the timing of rice stalk cutting does not influence the number of empty grains, implying that other factors may play a more significant role in determining grain quality.

This finding aligns with research by Liu et al. (2021), which indicated that genetic factors and environmental conditions such as soil moisture and temperature have a greater influence on the formation of full and empty grains than the timing of cutting itself. Overall, these results demonstrate that while the timing of rice stalk cutting is crucial for determining dry grain yield, it does not affect the number of empty grains per panicle. The rice plant's ability to adapt to various growing conditions may explain why the timing of cutting does not significantly affect the number of empty grains. Previous research indicates that factors such as proper fertilisation and pest control have a more substantial impact on grain quality (Tan et al., 2022).

Harvested Dry Grain Yield (GKP) per Plot

Statistical analysis indicated that the timing of rice stalk cutting significantly influenced the harvested dry grain yield per plot. The treatment with a 0-day cutting time (P0) produced the highest dry grain yield, reaching 2.87 kg. This was followed by the 3-

day treatment (P1), which yielded 2.52 kg. In contrast, the 6-day (P2) and 9-day (P3) treatments showed lower yields of 2.28 kg and 1.66 kg, respectively. The differences in dry grain yield among the treatments can be explained by the principles of rice plant physiology and the impact of cutting time on plant growth and development. Cutting the stalks at 0 days after harvest allows the plants to optimize photosynthesis and nutrient accumulation prior to cutting. This finding aligns with research by Smith et al. (2020), which suggests that selecting the appropriate cutting time can enhance yields by maximizing the utilization of plant resources.

The Least Significant Difference (LSD) test, conducted at a 5% significance level, revealed that the differences in dry grain yield between treatments P0 and P1, as well as between P1 and P2, were statistically significant. However, the differences between treatments P2 and P3 were not significant, indicating that longer cutting times after harvest (6 days and 9 days) did not yield the same benefits. The findings of this study demonstrate that the timing of rice stalk cutting has a notable impact on dry grain yield. Cutting the stalks at 0 days after harvest produced the best results, as the plants had adequate time to photosynthesize and store energy before being cut. In contrast, delaying the cutting to 9 days resulted in a significant decrease in yield, likely due to nutrient loss and the inability to utilize stored energy.

This research is consistent with previous findings reported by Nuzul et al. (2018), which indicated that the highest yield and yield components of ratoon rice were achieved when cutting was performed at a height of 3 cm above the soil surface, resulting in a grain yield of 3.54 tons per hectare. Additionally, research by Jones and Smith (2020) found that plant stress, particularly during the grain formation phase, can disrupt photosynthesis and the translocation of sugars from leaves to grains. This disruption can prevent proper grain filling, leading to a decrease in the number of fully developed grains per panicle and an overall reduction in grain yield. In contrast, early stem cutting does not interfere with this phase, allowing the plant to effectively allocate resources for grain filling. Other studies have shown that late stem cutting can diminish yields due to decreased grain quality and quantity. Johnson and Lee (2021) demonstrated that timely stem cutting can significantly enhance rice yields. Furthermore, research by Zhang et al. (2022) indicated that cutting stems at the optimal time can improve nitrogen use efficiency and yield. Additionally, findings by Tan et al. (2023) support these conclusions, showing that timely cutting of rice stalks can enhance both grain quality and yield.

CONCLUSION

Based on the research findings, the following conclusions can be drawn: (1) Cutting rice stalks immediately after harvest significantly impacts plant height, the number of tillers, the quantity of full grains per panicle, the number of empty grains per panicle, and the dry grain yield (GKP) per plot; (2) The optimal time to cut rice stalks is at zero days post-harvest, which means at the time of harvest; and (3) The timing of cutting stalks is crucial for the success of the SALIBU rice cultivation system. Therefore, farmers are advised to cut the stalks right at harvest time.

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