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The Effect of Foliar Application of Azolla Liquid Organic Fertilizer on Growth and Yield of Rice in Swampy Soil

Mei Rohayani[1], Widodo[1*], Masdar[1], Herry Gusmara[2]

[1]*Department of Crop Production, Faculty of Agriculture, University of Bengkulu, Bengkulu, 38121, Indonesia*
[2]*Soil Science Department, Faculty of Agriculture, University of Bengkulu,Bengkulu, 38121, Indonesia*

Corresponding Author : widodo@unib.ac.id

ABSTRACT

Rice cultivation faces challenges due to limited land availability despite increasing demand. Utilizing swamp land for cultivation presents an alternative, albeit hindered by difficult-to-control water conditions and less effective fertilizer spread. To ensure optimal nutrient supply, foliar application of Azolla liquid organic fertilizer (LOF) is explored. This study investigates the ideal concentration and frequency of Azolla LOF application for rice growth and yield. Employing a split plot design, the main plot assesses LOF concentration (3%, 6%, 9%, 12%), while the subplot evaluates application frequency (1, 2, 3 times). Results indicate that a 9% LOF concentration yields the highest tiller count (17.99), longest panicle (25.788 cm), highest grain count per panicle (158.2978), heaviest grain weight per hill (45.878 g), and highest grain weight per plot (3457.52 g). However, the fastest flowering period (54 DAP) occurs with a 12% LOF concentration. Applying Azolla LOF three times achieves the earliest flowering (55.25 DAP), while two applications yield the longest panicle (25.03 cm). Notably, no interaction is observed between LOF concentration and application frequency on rice growth and yield. These findings provide insights into optimizing Azolla LOF application for enhanced rice cultivation in swamp lands.

Keywords: Azolla, liquid organic fertilizer, rice cultivation, swamp land

INTRODUCTION

Rice is a staple food source in Indonesia and is widely consumed as a source of carbohydrates. Scientifically known as *Oryza sativa* L, rice holds significant importance in the country's economy and in fulfilling the basic needs of its people. Nearly all Indonesians rely on rice as their primary food source, leading to an increase in annual demand for rice, despite a decline in production. Several factors contribute to the suboptimal rice production, one of which is the low efficiency of fertilizers.

Based on the Central Statistics Agency's (2022) report, the area of rice-harvested land from 2019 to 2021 experienced a decrease due to land conversion, with production increasing in 2020 and sharply decreasing in 2021. Swamps can be an alternative for increasing agricultural production, particularly rice, given the shrinking agricultural land. However, uncontrolled water management often hinders rice farmers from utilizing these swamp lands effectively.

To maintain rice quality and production, efforts should be made to meet the plants' nutritional needs. One method to fulfill these needs is through foliar fertilization using Azolla LOF, as research by Musyarofah & Wibowo (2016) indicates that this approach increases rice plant productivity. Natural organic fertilizer, such as liquid organic fertilizer with varying concentrations, can enhance rice production quality, as demonstrated by Istiqomah *et al.* (2016). Although liquid organic fertilizer contains lower nutrient elements than solid fertilizer, it is more efficiently absorbed by plants, as stated by

Lestari *et al*. (2019). Moreover, applying fertilizer through the leaves, as opposed to traditional methods, can lead to higher productivity levels, as mentioned by Musyarofah & Wibowo (2016). Hence, applying liquid organic fertilizer through foliar application can improve productivity while addressing the fertilizer efficiency issue.

Azolla is an aquatic plant that can be used as an organic fertilizer for rice plants, as it is organic in nature. According to Simanjuntak (2005), using Azolla as a fertilizer can produce organic rice, which is relatively safe when compared to inorganic rice. The nutrients contained in Azolla are complete enough to be used as an organic fertilizer, with macro nutrients such as N, P, K, Ca, and Mg present, as well as micro nutrients consisting of elements such as Fe, Mn, Co, Na, Cl, Al, and Si (Widianingrum *et al*., 2021).

The chemical analysis of Azolla mycrophylla LOF conducted by Lestari *et al*. (2019) revealed that the pH found in *Azolla mycrophylla* LOF was 4.3. The macro nutrient content contained in *Azolla mycrophylla* LOF is N= 0.10%, P_2O_5= 0.02%, K_2O= 1.54%, Ca= 0.04%, and Mg= 0.01%. Additionally, the micro nutrient content contained in *Azolla mycrophylla* LOF is Mn= 55 ppm, Cu= 0.8 ppm, Na= 0.04%, Cl= 0.04%, Zn= 5.9 ppm, and S= 16 ppm. Based on the results of this analysis, *Azolla mycrophylla* LOF meets the organic fertilizer standards set forth by Minister of Agriculture Regulation No. 28 of 2009.

MATERIALS AND METHODS

The research was conducted between September 2022 and January 2023 in the Experimental Field of the Faculty of Agriculture at Bengkulu University, employing shallow wetlands as the research site. The following materials were utilized: UBPR 6 strain rice seeds, Azolla POC, and water. The tools and equipment utilized in the study included a large bucket, hoe, sickle, scissors, ruler, tape measure, sprayer, digital scale, plastic folder, permanent marker, net, paranet, and standard stationery equipment.

The factors tested consisted of two treatment factors, namely Azolla LOF concentration and Azolla LOF application frequency. The concentration factor of Azolla liquid organic fertilizer as the main plot, consists of four treatment levels, namely: concentration of 3%, 6%, 9% and 12%. Factor Frequency of application of Azolla liquid organic fertilizer (LOF) as a sub plot, consisting of three treatment levels, namely: frequency 1 time (2 WAP), 2 times (2, and 4 WAP), and 3 times (2, 4, and 6 WAP). The experimental units were placed according to the Split Plot Design. Each experimental unit was repeated 3 times. The number of plants per plot is 100 plants. The variables observed were plant height, number of offspring, flowering period, longest panicle, number of grains per panicle, percentage of grainy grain, weight of 1000 grains, heaviest grain weight per hill, and highest grain weight per plot.The data obtained was then analyzed using variance analysis (ANOVA). Comparison of means between treatments used Duncan's Multiple Range Test (DMRT) at the 5% level.

RESULTS AND DISCUSSION

Based on data from the Bengkulu Climatology Station, rainfall from November to January is 604.9 mm month-1, 353.6 mm month^{-1} and 330.1 mm month^{-1}. The average air temperature in November is 23.8 ^{o}C - 29.7 ^{o}C, December 23.9 ^{o}C - 29.9 ^{o}C and in January 23.7 ^{o}C - 30.0 ^{o}C. The average humidity is November 86%, December 84% and January 84.1%. The optimal temperature required by rice plants for growth is 23-25 ^{o}C and an altitude of 0 to 1500 meters above sea level. Rainfall for rice cultivation is 200 mm month^{-1} or more with a soil pH ranging from 4-7 (Tampubolon, 2013). The land used is swamp land which has a low pH, namely 4.96 (acid), N= 0.68%, P= 24.2 ppm and K= 0.27me 100 g^{-1}.

The rice plants under study exhibited robust growth. During the early flowering phase, they were subjected to infestation by rat pests. Control measures were implemented by erecting plastic fences and employing olfactory distraction using the scent of jengkol fruit to deter the rats. Additionally, avian pests posed a threat during the seed ripening phase, which was addressed by installing nets and employing auditory deterrence techniques near pagodas to repel the birds.

In addition to pest pressures, rice plants contended with nutrient competition from weeds. The experimental fields harbored both narrow-leafed and broad-leafed weed species. Weed management techniques involved manual removal through burial and herbicide application.

Analysis of variance (ANOVA) results indicating no interaction between the concentration and frequency of application. However, the concentration of Azolla LOF applied via foliar spray significantly influenced various variables, including tiller count, flowering onset, panicle length, grains per panicle, individual grain weight, and overall plot grain weight. Conversely, the frequency of Azolla LOF foliar application yielded significant effects solely on flowering period and panicle length (Table 1).

Table 1. Analysis of variance of gowth and rice yields in swamplands due to application of Azolla LOF through leaves

Variable	F- value			CV (K) %	CV (F) %
	Concentration (K)	Frequency (F)	Interaction		
Plant height	1.6515 ns	2.1468 ns	0.357 ns	5.44	2.51
Highest tiller count	11.7097 *	0.917 ns	0.7556 ns	5.62	5.99
Flowering period	20.9024 **	7.7619 **	1.1587 ns	1.89	2.35
Longest panicle	9.8415 **	5.4847 *	2.1293 ns	3.13	3.42
Number of grains per panicle	13.2364 **	0.0713 ns	0.1956 ns	15.7	6.88
Percentage of grainy grain	1.1710 ns	2.5818 ns	0.6608 ns	2.89	2.95
Weight of 1000 grains	0.5253 ns	0.8407 ns	1.2861 ns	10.2	8.55
Heaviest grain weight per hill	26.1144 **	1.8117 ns	0.8852 ns	11.73	11.12
Highest grain weight per plot	28.5746 **	1.7107 ns	0.9126 ns	11.32	11.91

Note : * = significant ($p<0.05$); ** = highly significant ($p<0.01$); ns = non-significant ($p\geq0.05$)

Table 2. Average height of rice plants in swamp land due to application of Azolla POC through leaves

Frequency	Concentration (%)				Mean
	3	6	9	12	
	--- cm ---				
1 x	98.33	99.93	105.17	100.17	100.9
2 x	99.67	102.07	104.93	100.8	101.87
3 x	100.7	102.03	105.6	103.9	103.06
Mean	99.57	101.34	105.23	101.62	101.94

The highest average plant height at the concentration treatment level of giving Azolla LOF through the leaves was 9%, namely 105.23 cm. Meanwhile, the average height of UBPR 6 rice plants, namely 101.94 cm, was much higher than the control that was not given fertilizer, namely 72.93 cm, even the control that was given fertilizer was only 82.83 cm tall. In the treatment, the frequency of giving Azolla LOF through the leaves resulted in rice plant height that did not show a significant difference. The frequency of giving 3 times resulted in an average rice plant height of 103.06 cm, the frequency of giving 2 times an average of 101.87 cm and the frequency of giving 1 time an average of 100.90 cm (Table 2). The criteria for rice plant height based on the Rice Standard Evaluation System are short, rather short (<90 cm), medium (90-125 cm) and tall (>125 cm) (IRRI 2002 *In* Arianti & Lubis, 2018). Based on research by Sumardi *et al.* (2021), shows that the plant height of the UBPR 6 line has an average plant height of 98.47 cm, which is included in the medium criteria.

At the concentration treatment level of foliar application of Azolla LOF, the average highest tiller count exhibited no significant difference among various concentrations: 15.66 tillers for 3%, 16.26 tillers for 6%, and 15.91 tillers for 12%. However, the 9% concentration treatment yielded a notably higher average of 17.99 tillers, demonstrating significant divergence from other concentrations (Figure 1). Regarding frequency treatment levels, no substantial differences were observed among the three frequencies. Notably, the highest number of tillers was produced by the twice-per-treatment frequency, averaging 16.65 tillers, followed by the thrice-per-treatment frequency, while the once-per-treatment frequency resulted in the fewest offspring, with an average of 16.14 tillers.

Chaniago (2017) categorizes tiller numbers into three groups: few (less than 10 tillers), medium (11-20 tillers), and many (more than 20 tillers). In accordance with this classification, the average highest tiller count of 16.45 tillers falls within the medium category. Furthermore, Sukendah *et al.* (2023) also reported research results on the concentration of liquid organic fertilizer.

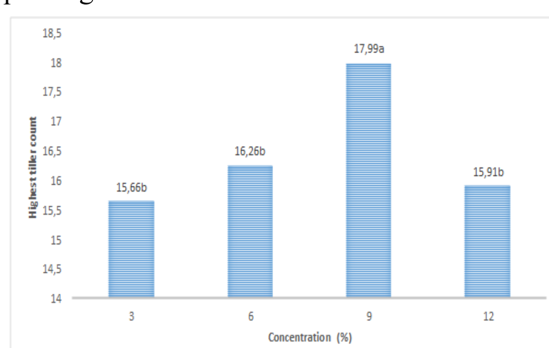


Figure 1. Highest tiller count UBPR 6 Rice Plants at Azolla LOF concentration through the leaves

Based on the histogram depicted in Figure 1, it is evident that UBPR 6 rice plants attained their highest tiller count at a concentration of 9%, registering 17.99 tillers, outperforming the fertilized control, which yielded 15.93 tillers. Conversely, at a 12% concentration, the tiller count decreased compared to the 9% concentration, with 15.91 tillers recorded. Asnijar *et al*. (2013) notes that excessive fertilizer application can lead to plant poisoning, hindering growth rates and potentially resulting in plant mortality. The treatment with a 3% concentration exhibited the lowest tiller count, recording 15.66 tillers .

The highest tiller count is attributed to the adequate supply of essential nutrients for plant growth. Nutrient availability, particularly nitrogen (N) in the leaves, plays a pivotal role in influencing photosynthesis rates and subsequent growth and tiller production (Istiqomah *et al*., 2016). Additionally, research conducted by Pratama *et al*. (2016) revealed significant effects of Azolla LOF concentration and cow urine on tiller count and calf productivity. Specifically, applying Azolla liquid organic fertilizer at a concentration of 175 mL L^{-1} of water resulted in the highest tiller count, reaching 23.50 tillers.

The average flowering period shows that the two treatment levels are significantly different from the flowering period variable. The fastest flowering period at the treatment level was the concentration of Azolla LOF through the leaves, namely 12%, with an average of 54.67 DAP, and the longest, namely 3% concentration, average of 58.11 DAP (Figure 2a). From this picture, it can be seen that the higher the concentration of Azolla LOF fertilizer given, the faster the flowering period. The P content in Azolla is quite high, namely 0.48, which can speed up the flowering period and fruit ripening, according to Sarief's statement (1985 *In* Rahim *et al*., 2017) which states that phosphorus can stimulate the growth of roots and young plants and speed up the flowering period and fruit ripening.

The flowering period in UBPR 6 rice plants that were treated with the frequency of giving Azolla LOF through the leaves was the fastest, namely in F3 (3 times), namely 55.25 DAP and the slowest flowering period, namely in F1 (1 time) 57.33 DAP. The diagram shows that frequency influenced the flowering period of the UBPR 6 rice plants (Figure 2b).

Compared to the control group with a flowering period of 60 days after planting (DAP), rice plants treated with Azolla liquid organic fertilizer (LOF) through foliar application exhibited accelerated flowering. The fastest flowering occurred at 54.67 DAP with a 9% concentration treatment, administered thrice at intervals of 2, 4, and 6 weeks after planting (WAP). This treatment regimen effectively provided the necessary nutrients for the vegetative phase, crucial for flower formation. Thus, the timely application of Azolla LOF ensured adequate nutrient supply during flower development

In general, the timing of harvest is closely linked to flowering. Harvesting occurs uniformly at 90 DAP when the rice plants reach maturity. The UBPR 6 rice variety used in this study matures 110 days after sowing, typically flowering around 77.7 days after sowing (Sumardi *et al*., 2021). Harvest readiness is determined visually, with approximately 80% of the rice population displaying a golden yellow coloration.

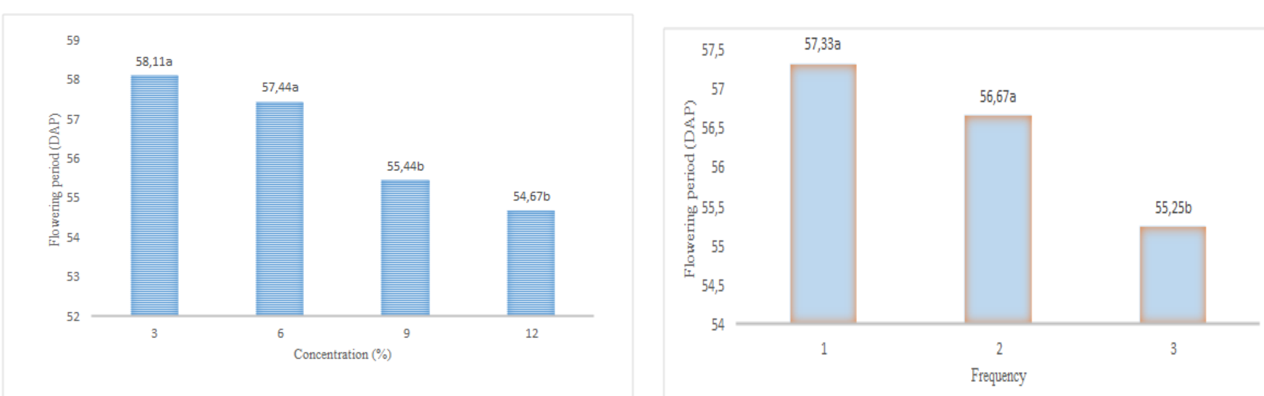


Figure 2. Flowering period UBPR 6 Rice Plants at Azolla LOF concentration and frequency

The average longest panicle at the concentration treatment level of giving Azolla LOF through the leaves at a concentration of 3%, namely 24.2944 cm, a concentration of 6%, namely 24.44 cm, and a concentration of 12%, namely 23.95 cm, did not show a difference between the three, but was different at a concentration of 9 % namely 25.7878 cm. (Figure 3a). The frequency of giving Azolla LOF through the leaves at a frequency of 1 time, namely 23.969 cm, is significantly different from a frequency of 2 times, namely 25.0235 cm and a frequency of 3 times, namely 24.8525 cm (Figure 3b) .

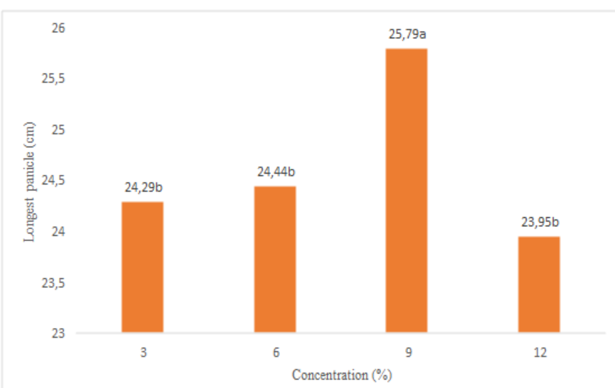
UBPR 6 rice plants that were treated with a concentration of Azolla LOF through the leaves showed a striking difference at a concentration of 9% with the longest panicle at 25.788 cm which was the plant with the longest panicle when compared to a concentration of 3%, namely 24.94 cm, a concentration of 6%, namely 24. 44 cm, and a concentration of 12% with the longest panicle 23.95 cm which is the plant sample with the shortest longest panicle (Figure 3a). The longest panicle is influenced by the nutrient N. According to Rahmaniah, (2021) the application of Azolla organic fertilizer has an influence on the longest panicle which is related to rice crop yields, the longer the panicle, the greater the total amount of grain.

The longest panicle, observed twice, measured 25.03 cm, and did not significantly differ from the longest panicle observed thrice, which measured

The highest grain count per panicle of UBPR 6 rice plants was produced by a concentration of 9%, namely 158.3, which was different from a concentration of 6% with several grains of 110.75, a concentration of 12% with several grains of 113.85 and a concentration of 3% with several grains of 109. 85 (Figure 4). When compared with the control that was given fertilizer, it was 124.48 grains and that was not given any fertilizer at all, namely 120.28 grains.

Providing LOF concentration influences the longest panicle and the number of panicles per clump of local rice plants. The ability of rice plants to produce the number of grains per panicle is influenced by the longest panicle and the availability of nutrients, the nutrient N influences the number of grains per panicle (Sukendah *et al*., 2023). Azolla liquid organic fertilizer (LOF) has enough N nutrients for plant needs. The treatment of giving a concentration of 9% (9 mL 100 mL^{-1} water) Azolla LOF through the leaves was the best treatment for the variable highest grain count per panicle when compared with the control given fertilizer.

The highest percentage of pithy grain at the treatment level of giving Azolla LOF through leaves was 3%, namely 88.8633% and the lowest was 6%, namely 86.8933%. Meanwhile, for the treatment frequency of giving Azolla LOF through the leaves, the percentage of pithy grain showed quite significant differences, but the highest was a frequency of 3 times which produced 89.1017%, a frequency of



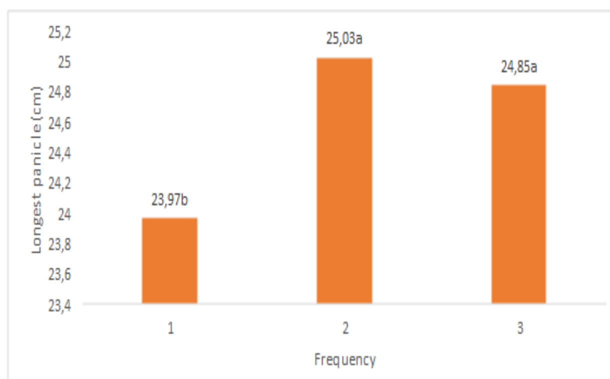


Figure 3. Longest panicle UBPR 6 rice plants at Azolla LOF concentration and frequency

24.85 cm. The average longest panicle length across Azolla LOF frequency treatments was 24.61 cm, with the shortest observed at 23.97 cm in the single application frequency. There was a significant disparity between single application and double or triple applications (Figure 3b). For the longest panicle parameter, the application frequency of twice or thrice

2 times which resulted in 88.5325% and the lowest percentage was produced by a frequency of giving 1 time, namely 86.79% (Table 3).

The percentage of rice grains is influenced by sufficient nutrients in the photosynthesis process so that the photosynthesis process runs well. However, giving a single LOF without N, P, K fertilizer gave unreal results on the percentage of rice grain (Habibullah *et al*., 2015). Nutrients provided through the leaves by spraying will make it easier for plants to process photosynthesis. However, the application of fertilizer through leaves also needs to be supported by environmental conditions such as wind, hot sun rainwater, or morning dew. If environmental conditions do not support it, the nutrients contained in the liquid organic fertilizer that is sprayed cannot be absorbed optimally by plants.

In the concentration treatment involving the application of Azolla LOF through the leaves, the weight of 1000 dry milled grains varied significantly. The heaviest weight, recorded at a 12% concentration, amounted to 25.4978 g, while the lightest weight, observed at a 3% concentration, measured 24.2622 g. Furthermore, altering the frequency of Azolla LOF application through the leaves resulted in varying grain weights. Specifically, a single application led to the lowest weight, averaging 24.5767 g, followed by three applications at 24.4725 g, and two applications at the heaviest weight of 25.495 g. However, compared to the control group receiving fertilizers spread over the ground, with a weight of 28.88 g per 1000 dry milled grains, the treatment of Azolla POC through the leaves exhibited no significant impact on grain weight. This lack of effect is attributed to suboptimal nutrient absorption through the leaves, which fails to influence the weight of milled dry grains. Nonetheless, the nutrient-rich content facilitates efficient photosynthesis, resulting in increased photosynthate production and, consequently, the potential for enhanced milled dry grain weight (Habibullah *et al*., 2015).

Significant differences in average heaviest grain weight per hill and plot were observed among different concentrations of Azolla LOF. The highest recorded grain weight per hill was associated with a 9% concentration, averaging 45.878 g. Following this, the 3% concentration exhibited the second highest grain weight per hill at 31.947 g, followed by the 6% concentration at 31.722 g. Notably, the 12% concentration yielded the lowest recorded weight at 31.665 g (Figure 5). When compared to the control group without fertilizer, producing 11.251 g per hill, the treated plants demonstrated significantly higher grain weights per hill. Even when compared to the control group receiving spread fertilizer, averaging 16.408 g per hill, the treated plants still displayed considerable weight gains.

The concentration of 9% yielded the highest average grain weight per plot, reaching 3457.52 g per hill. Following this, the 3% concentration exhibited an average grain weight per plot of 2396.0042 g, and the 6% concentration resulted in a weight of 2389.344 g. Conversely, the 12% concentration produced the lowest average weight, measuring 2374.87 g (Figure 5). In comparison to the control group without fertilizer, which recorded a weight of 432.19 g, the treated plants exhibited the highest grain weight per plot. This increase was notable even when compared to the control group receiving spread fertilizer, with a weight of 1134.88 grams.

Table 3. Effect of foliar application of Azolla LOF on percentage of grainy grain and weight of 1000 grains

Variable	Frequency	Concentration (%)				Mean
		3	6	9	12	
Percentage of grainy grain (%)	1 x	88.58	84.56	87.29	86.73	86.79
	2 x	88.81	88.84	87.923	88.55	88.53
	3 x	89.2	87.27	88.8	91.13	89.1
	Mean	88.86	86.89	88.01	88.8	88.81
Weight of 1000 grains (g)	1 x	24.16	25.02	24.29	24.83	24.58
	2 x	24.18	25.03	24.38	28.39	25.5
	3 x	24.45	25.67	24.5	23.267	24.47
	Mean	24.26	25.24	24.39	25.5	24.85

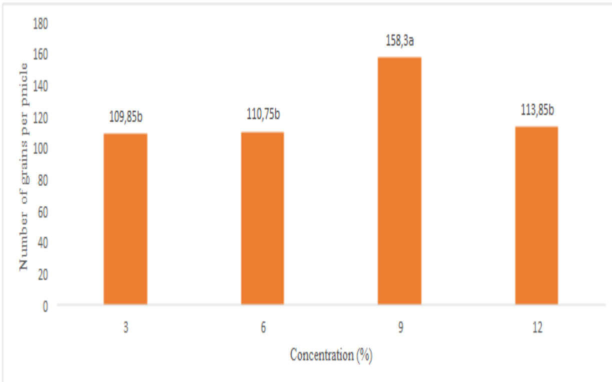


Figure 4. Number of grains per panicle of UBPR 6 rice plants at Azolla LOF concentration

The nutrients present in Azolla liquid organic fertilizer exert a significant influence on both the heaviest grain weight per hill and per plot. Research conducted by Istiqomah *et al*. (2016) indicates that the application of liquid organic fertilizer affects the dry weight of grains per hill. In addition to macro nutrients, micro nutrients also play a vital role in the growth processes of rice plants. Micronutrients found in Azolla LOF effectively fulfill the plants' nutritional requirements, thereby impacting grain yield positively.

The research site utilized for this study lies within the Lebak swamp, an area prone to periodic flooding (Djamhari, 2009). This condition hampers optimal nutrient absorption by the plants. Fertilization through foliar application aids in more efficient nutrient absorption, particularly in swampy conditions, where traditional spread fertilization methods prove less effective. Liquid organic fertilizers are readily absorbed by plants through stomata (Niis & Nik, 2017). The Azolla LOF utilized in this study contained 1.74% N, 0.48% P, and 0.78% K.

Azolla LOF concentration through the leaves of 9% produces the best rice growth and yield. Meanwhile, a concentration of 12% shows a decrease in growth and yield. The frequency of giving Azolla LOF has a significant effect on the flowering period and longest panicle. This decrease is thought to be due to the rice plants experiencing an excess dose or the concentration given, namely 12%, being inappropriate. Based on Minister of Agriculture Regulation No. 13 2022 concerning the Use of N, P, K Fertilizer Doses for Rice, Corn and Soybeans on Paddy Fields, the fertilizer dose for paddy plants in paddy fields in Bengkulu Province, Muara Bangka Hulu District for the dosage of N (Urea) compound fertilizer is 175 kg ha^{-1}. Meanwhile, in this study, the dose of Azolla LOF at a concentration of 12% was 288 L ha^{-1}, and other concentrations, namely 3%, was 72 L ha^{-1}, 6% was 144 L ha^{-1} and 9% was 216 L ha^{-1}.

The findings of Dewi's research (2016) indicate that overly concentrated foliar fertilizer induces plasmolysis in cells, causing the leakage of cellular fluid. Dewi's study revealed that applying a concentration level of 2.5 mg L^{-1} did not enhance the weight of 1000 grains or the dry grain weight per hill. However, a concentration level of 2.0 mg L^{-1} proved suitable for increasing both components of rice yield. These results align with our study, where administering a 12% concentration of Azolla LOF through foliar application, equivalent to 12 mL per 100 mL of water, ceased to enhance several observed variables. Conversely, providing Azolla LOF at a 9% concentration, i.e., 9 mL per 100 mL of water, proved effective in enhancing various variables, including plant height, highest tiller count, longest panicle, number of grains per panicle, heaviest grain weight per hill, and highest grain weight per plot.

In Niis & Nik's research (2017), the frequency of spraying liquid organic fertilizer showed negligi

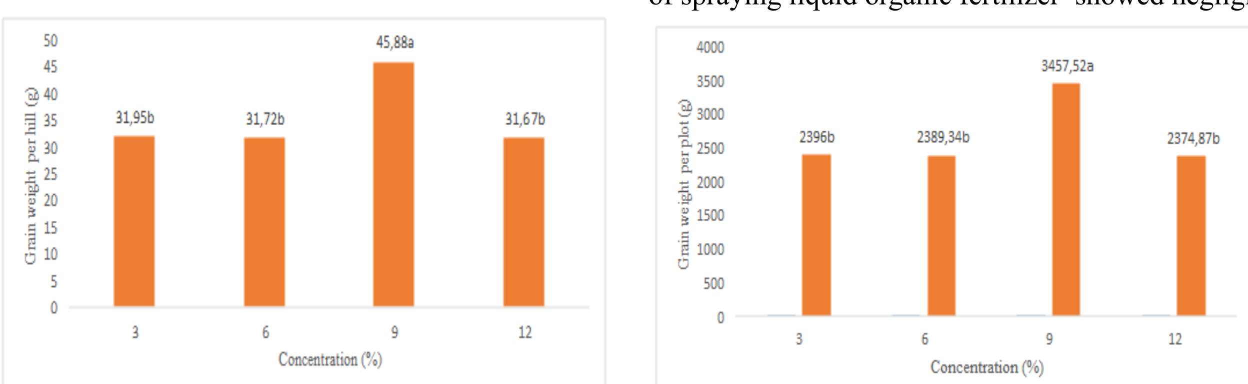


Figure 5. Grain weight on UBPR 6 rice plants in the Azolla LOF concentration

ble effects on the observed variables, mirroring the outcomes of our study, where several variables exhibited minimal impact. Only the variables of flowering period and longest panicle demonstrated significant effects. For the flowering period, the optimal treatment was observed at a frequency of 3 times, while for the longest panicle variable, both 2 times and 3 times frequencies were deemed effective. This suggests that a single application of Azolla LOF at 2 WAP fails to meet the nutrient requirements at each phase of rice plant growth, hence necessitating multiple applications.

CONCLUSION

The findings from this study indicate that there exists no significant interaction between the concentration and frequency of Azolla LOF application through the leaves concerning rice growth and yield. Independently applying Azolla LOF at a concentration of 9% through the leaves yielded the most favorable outcomes, evidenced by the highest tiller count (17.99), longest panicle (25.788 cm), highest grain count per panicle (158.2978), heaviest grain weight per hill (45.878 g), and highest grain weight per plot (3457.52 g). Nonetheless, the most rapid flowering period was observed with a 12% concentration of Azolla LOF applied foliarly, occurring at 54 days after planting (DAP). Regarding the frequency of foliar Azolla LOF application, applying it three times (at 2, 4, and 6 weeks after planting (WAP)) yielded the shortest time to flowering (55.25 days), while the longest panicle was achieved by applying Azolla LOF foliarly twice (at 2 and 4 WAP), measuring at 25.03 cm.

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