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Analysis Plant Growth, Yield and Efficiency of Nitrogen Fertilization in Paddy using Green Manure of Azolla

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Abstract: The development and improvement of cultivation techniques can be done to improve soil fertility; one of the techniques is the application of organic matter. This research intends to study the interaction between Azolla application treatments with different doses of inorganic fertilizers and find out the appropriate dose of Azolla for inorganic fertilizers. This study was conducted in the experimental field of the faculty of agriculture at the university of Brawijaya located in Jatimulyo Village, Lowokwaru sub-district, Malang City in June and November 2021. This study used a split-plot design with 4 levels of N fertilizer dose as the main plot and 4 levels of Azolla dose as the subplot. The total combination of treatments was 16 and was repeated 3 times, so the total experimental plots were 48 plots. Azolla treatment with a dose of 6,800 kg ha^{-1} and fertilizer N 166.41 kg ha^{-1} had better growth compared to other doses of Azolla and fertilizers N. In the yield component, there was an interaction between Azolla and N fertilizer, except for the variable percentage of grain. Azolla treatment with the dose of 6,800 kg ha^{-1} along with the used fertilizer N in the dose of 166.41 kg ha^{-1} can increase the productivity of paddy plants by 10-20.5%, the increase in rice yields is obtained by increasing the nitrogen content of the soil through the application of Azolla as green fertilizer.

Keywords: Nutrient Uptake, Organic Fertilizer, *Oryza sativa* L., Urea

Introduction

Paddy is a staple food plant that is widely cultivated in Indonesia. The agricultural cultivation system for paddy commodities in Indonesia leads to intensification. Intensification of agriculture in paddy commodities is mostly carried out, one of which is in paddy fields, in addition to continuous irrigation levels, the use of chemical fertilizers and chemical pesticides is also high.

One of the centers for paddy plant production in Indonesia is in East Java, based on (Statistics Indonesia, 2021), East Java is capable of producing 9.90 million tons of dry-milled grain in 2021. This number has decreased by 0.36% compared to last year's 9.94 million tons of dry-milled grain. One salient aspect to be focused on in the lowland paddy cultivation system in the area of East Java is the level of chemical fertilization applied by farmers is very intensive. Intensive fertilization with large amounts of chemical fertilizers can decrease soil quality, the impact can still be felt now, such as the extent of paddy production has been decreasing (Yao *et al*., 2018). The results of research conducted by Kern and Vlek (2007) on the efficiency of the use of lowland paddy production factors, explain that the use of production factors including Urea, SP-36, and KCl fertilizers is much greater than the recommendation issued by the government for farmers.

Excessive use and or inappropriate fertilization time can damage plants and result in inefficient use of inputs. In general, many farmers use urea (nitrogen) fertilizers in paddy plants more than other fertilizers, because nitrogen fertilizers are relatively cheap compared to other fertilizers. Continuous use of unbalanced fertilizers on paddy or other crops can exacerbate soil degradation and lead to increased pest problems and diseases. The plant's response towards Nitrogen fertilizers is very fast and the effect can be immediately seen in the color of paddy leaves from green to dark green within 2-3 days after application. The use of excessive nitrogen fertilizer is considered to be one of the causes of the decline in paddy productivity in intensive paddy fields.

An improvement of cultivation techniques that can be done to improve soil fertility is by applying organic fertilizers. Based on Gitosuwondo (2012) statement, around 73% of agricultural land in Indonesia is composed of low organic matter <2%. To overcome the problem of soil fertility that continues to decrease and the behavior of farmers who are very dependent on the use of Nitrogen (N) fertilizer, it is necessary to find a solution to overcome these issues. One of the expected solutions is the introduction and application of techniques for using organic Azolla fertilizers in lowland paddy cultivation systems (Setiawati *et al*., 2018). Azolla is one of the ingredients that can be used as green manure. The application of green manure in agricultural land is useful for increasing organic matter and nutrients in the soil as well as soil characteristics that have a positive impact on productivity. Azolla is an aquatic plant that restrains floating nitrogen in the air with the help of the blue-green algae Anabaena azollae, then quickly decomposes and releases nitrogen compounds into the soil which is beneficial for paddy plants. application of azolla to rice plants can significantly increase yields of dry rice grain (Thapa and Poudel, 2021). The application of Azolla green manure is expected to reduce the use of inorganic fertilizers. Therefore, the purpose of this study was to determine the effect of using Azolla on the efficiency of nitrogen (urea) fertilization in lowland paddy cultivation to improve soil conditions and increase optimal paddy production.

Materials and Methods

This research was conducted from June to November 2021 in the experimental field in the faculty of agriculture, Universitas Brawijaya, located in Jatimulyo Village, Lowokwaru district. The study used a split-plot design with 16 treatments and repeated 3 times so that the total experimental plots were 48 plots. The main plot is Inorganic fertilizer (P) which consists of 4 levels, namely:

1. P1: 25% N fertilizer (55.47 kg ha^{-1})
2. P2: 50% N fertilizer (110.94 kg ha^{-1})
3. P3: 75% N fertilizer (166.41 kg ha^{-1})
4. P4: 100% N fertilizer (221.88 kg ha^{-1})

Meanwhile, the subplots are the number of Azolla (A) consisting of 4 levels, namely:

1. A1: Azolla 25% (1,700 kg ha^{-1})
2. A2: Azolla 50% (3,400 kg ha^{-1})
3. A3: Azolla 75% (5,100 kg ha^{-1})
4. A4: Azolla 100% (6,800 kg ha^{-1})

The preparation of paddy seedlings was performed by soaking the seedlings for 24 h later sown in the nursery evenly, the seedlings were planted 21 days after sowing. Seedlings were planted as many as 2 seedlings per planting hole at a spacing of 25 × 12.5 × 50 cm. Azolla manure was given after the paddy seedlings were planted, then fresh Azolla was distributed evenly in each experimental plot according to the treatment; SP-36 with a dose of 150 kg ha^{-1} was applied when the plants were 7 DAP; KCL fertilizer with a dose of 100 kg ha^{-1} was given twice, namely at 7 DAP at 30% and 30 DAP at 70%; Urea with a dose of 221.88 kg ha^{-1} (100%), 166.41 kg ha^{-1} (75%), 110.94 kg ha^{-1} (50%), 55.47 kg ha^{-1} (25%) given 2 times, namely at 7 DAP as much as 30% and 30 DAT as much as 70%. SP-36, KCL, and Urea were applied by spreading fertilizer on the treatment plots.

Determination of the dose of Nitrogen and Azolla

fertilizer determination of the dose of urea and Azolla fertilizer is known by calculating the dose of nutrients that must be added according to the desired soil condition for the criteria of medium N 0.21-0.5% with the formula:

$$\frac{A2-B}{A1-A2}=\frac{\frac{U}{N}-Xa}{Xa-Xb}$$

where:

U/N = The dosage of elements nutrients that must be added according to the desired soil condition
$A1$ = The top content of the U range of total soil criteria (%)
$A2$ = The lowest content of the U range of total soil criteria (%)
B = The total U content of the soil as a result of chemical concentration observations (%)
Xa = The value of the highest dose of plant U requirement/Ha (mg/kg)
Xb = The lowest value of plant U requirement dose (mg/kg)

It was found that the nitrogen requirement that must be added to enter the medium category was 102.07 kg ha^{-1} with a urea dose of 221.89 kg ha^{-1} and Azolla 6759.6 kg ha^{-1}.

Plant Growth Observation

Plant growth observations were conducted destructively by taking three plant samples for each treatment carried out when the plants were 20 to 70 DAP with 10-day intervals for observing the weight of wet and dry plants and a non-destructive way for observing plant length, leaf area, and several leaves.

Initial Soil Sampling Methods

Initial soil samples were taken when the land was in dry conditions. Soil samples were taken randomly at several random points which were then mixed into composite soil samples. Soil samples were taken with two replications. Soil samples were taken at a depth of 10-20 cm below the soil surface using soil drill augers designed to make sure that the volume of soil taken in each sampling (6).

Soil Sampling Method After Harvests

Soil samples after harvest were taken after the harvesting process was carried out, to determine the effect of treatment on changes in soil nutrient conditions. Soil sampling after harvest was carried out on each experimental plot. Soil samples were taken randomly at several random points which were then mixed into composite soil samples. Soil samples were taken with two replications. Soil samples were taken using a soil drill at a depth of 10-20 cm below the soil surface.

Soil Analysis

Soil analysis was carried out to determine the content of N, P, K, and C-organic, pH, and soil water content. Soil chemical analysis was carried out on initial soil samples and post-harvest soil samples. Soil sample analysis was carried out in the soil chemistry laboratory of the faculty of agriculture, Brawijaya university, Malang.

Harvest Analysis

The observations of harvest yields included the percentage of productive tillers, productivity, dry weight of grain, number of panicles per clump, the weight of 1000 grains, and grain quality. Besides that, supporting observations were also carried out, namely fresh Azolla analysis and soil analysis regarding the initial and final state of soil quality.

Statistical Analysis

The observational data obtained were analyzed using analysis of test variance (F-test) at the 5% level. If there are significantly different results, it will be continued with the LSD test at the 5% level (Gomez and Gomez, 1984).

Results and Discussion

Growth Components

Based on the Table 1-3 the paddy plants with different doses of Azolla and N fertilizer, shows the effect on the growth of plant length, leaf area and number of tillers at the end of the observation, which was 40-60 DAP. Based on this, Azolla green manure affects the growth of paddy plants, according to Razavipour *et al*. (2018) the application of Azolla can increase the availability of N elements for plants and increase the organic compound in the soil, so that plants' growth becomes better because plants can absorb nutrients optimally.

In plants’ tissue, nitrogen is a constituent component of many compounds which is essential for plants, such as amino acids. Because every protein molecule is composed of amino acids and every enzyme is composed of protein and an enzyme. In addition, nitrogen is also a constituent matter of proteins and enzymes. Moreover, nitrogen is also contained in chlorophyll, cytokinin hormones, and auxins (Cissé and Vlek, 2003). The application of Azolla 6,800 kg/ha^{-1} had a significant effect compared to the application of Azolla with smaller doses of Azolla. This is presumably because Azolla can contribute nitrogen elements to paddy plants either through the fixation process or from the decomposition process. Thus, the higher the dose of Azolla given; the more paddy plant growth will be.

Based on this research, the application of Azolla and N fertilizer is expected to reduce the use of N fertilizer through the addition of Azolla, because Azolla can provide sufficient N intake to support the growth of paddy plants. After all, the N element in the soil can increase the growth of a plant, according to (Razavipour *et al*., 2018) that the role of N for plants is to stimulate overall vegetative growth, especially stems, branches and leaves. According to research by Yang *et al*. (2021), it was stated that urea fertilization with a dose of 200 kg ha^{-1} increased the highest paddy yield.

Table 1: Plant length as the effect of Azolla and n fertilizer at various ages observation

	Length of paddy plants (cm^2 plant^{-1}) at age (DAT)					
Treatment	20	30	40	50	60	70
Azolla manure:						
Azolla 1,700 kg ha^{-1}	29.09	42.77	52.41^{a}	63.78^{a}	76.37^{a}	93.37^{a}
Azolla 3,400 kg ha^{-1}	29.21	43.45	53.89^{ab}	63.56^{a}	77.97^{a}	94.98^{a}
Azolla 5,100 kg ha^{-1}	29.60	43.17	54.35^{ab}	64.00^{a}	78.56^{a}	95.57^{a}
Azolla 6,800 kg ha^{-1}	30.22	43.19	56.07^{b}	67.82^{b}	84.45^{b}	99.79^{b}
LSD 5%	ns	ns	2.72	2.88	3.07	2.88
Fertilizer N:						
Fertilizer N 55.47 kg ha^{-1}	29.89	44.04	54.58	64.73	78.78^{ab}	94.92^{a}
Fertilizer N 110.94 kg ha^{-1}	29.06	43.93	52.67	62.83	76.88^{a}	93.02^{a}
Fertilizer N 166.41 kg ha^{-1}	29.47	42.90	55.77	67.76	83.80^{b}	101.74^{b}
Fertilizer N 221.88 kg ha^{-1}	29.70	41.71	53.69	63.84	77.89^{a}	94.03^{a}
LSD 5%`	ns	ns	ns	ns	5.23	2.85

Note: Numbers accompanied by the same letter in the same column show that they are not significantly different based on the 5% LSD test; ns = not significant

Table 2: Paddy leaf area as the effect of Azolla and n fertilizer at various ages observation

Treatment	Leaf Area (cm^2 plant^{-1}) at age (DAT) 20	30	40	50	60	70
Azolla manure:						
Azolla 1,700 kg ha^{-1}	236.37^a	389.24^a	641.65^a	767.58^a	961.48^a	1054.62^a
Azolla 3,400 kg ha^{-1}	232.97^a	383.24^a	644.85^{ab}	772.04^a	972.79^a	1043.44^a
Azolla 5,100 kg ha^{-1}	272.86^b	416.59^{ab}	675.18^{bc}	804.96^{ab}	1005.46^{ab}	1063.42^a
Azolla 6,800 kg ha^{-1}	294.77^b	447.02^b	704.57^c	853.36^b	1046.45^b	1177.85^b
LSD 5%	33.87	38.61	33.41	44.74	48.66	49.49
Fertilizer N:						
Fertilizer N 55.47 kg ha^{-1}	235.56^a	384.77^a	650.12^a	785.48^a	982.07^a	1070.88^a
Fertilizer N 110.94 kg ha^{-1}	247.14^a	396.37^a	651.41^a	779.22^a	975.46^a	1078.57^a
Fertilizer N 166.41 kg ha^{-1}	299.69^b	446.87^b	702.75^b	841.10^b	1042.40^b	1127.63^b
Fertilizer N 221.88 kg ha^{-1}	254.57^a	408.08^a	661.97^a	792.14^a	986.25^a	1062.26^a
LSD 5%	34.57	31.69	29.68	51.05	47.79	48.54

Note: Numbers accompanied by the same letter in the same column show that they are not significantly different based on the 5% LSD test; ns = not significant

Table 3: Number of tillers as the effect of Azolla and n fertilizer at various ages observation

Treatment	Number of paddy tillers at the age (DAT) 20	30	40	50	60	70
Azolla Manure:						
Azolla 1,700 kg ha^{-1}	8, 86	14.53	16.64	20.79	24.69^a	30.09^a
Azolla 3,400 kg ha^{-1}	8.83	15.03	16.97	22.92	26.00^a	31.48^a
Azolla 5,100 kg ha^{-1}	9.64	14.81	19.81	22.31	25.72^a	31.68^a
Azolla 6,800 kg ha^{-1}	9.25	14.81	18.33	22.28	29.53^b	36.16^b
LSD 5%	ns	ns	ns	ns	3.45	3.09
Fertilizer N:						
Fertilizer N 55.47 kg ha^{-1}	9.19	14.67	17.78	22.66	25.43^a	30.69^a
Fertilizer N 110.94 kg ha^{-1}	9.25	14.50	17.44	21.58	24.76^a	30.47^a
Fertilizer N 166.41 kg ha^{-1}	9.50	14.89	18.17	22.00	29.63^b	36.41^b
Fertilizer N 221.88 kg ha^{-1}	8.64	15.11	18.36	22.05	26.13^{ab}	31.83^a
LSD 5%	ns	ns	ns	ns	3.93	3.35

Note: Numbers accompanied by the same letter in the same column show that they are not significantly different based on the 5% LSD test; ns = not significant

Yield Components

Based on the Table 6 and 7, it was shown that the application of Azolla manure and N fertilizer had a significant interaction on the productivity and the weight of dry paddy, but had no significant intercation on the number of panicles per clump and percentage of pithy grain (Table 4 and 5). This is because the formation of good vegetative organs will affect generative growth. Patra and Haque (2011) state that a plant with good vegetative growth will ultimately determine the generative phase and yield of the plant. One of the increases in yield is due to leaf area because of the function of the leaf as a producer of photosynthate which is needed by plants as an energy source in the process of growth and development (Yao *et al*., 2018).

The results showed that the treatment with a dose of Azolla 6,800 kg ha^{-1} along with the use of an N dose of 166.41 kg ha^{-1} could increase the productivity of paddy plants by 10-20.5%, it was presumed that the presence of Azolla was able to help N available to plants, then, plants can absorb it optimally. Based on Mahmudah *et al*. (2017), Azolla as green manure can produce nitrogen that is immediately available to accelerate plants' growth. It can also be seen that Azolla green manure can help the absorption of N for the growth and development needs of paddy plants. Optimization of paddy productivity per unit area and time can be done by intensifying agriculture through proper cultivation. This research is expected to reduce the use of N fertilizer through the addition of organic Azolla green manure.

Table 4: Number of panicles per clump as the effect of Azolla and n fertilizer

Treatment	Number of panicles per clump (panicle)
Azolla Manure:	
Azolla 1,700 kg ha^{-1}	8.78[a]
Azolla 3,400 kg ha^{-1}	12.49[b]
Azolla 5,100 kg ha^{-1}	12.81[bc]
Azolla 6,800 kg ha^{-1}	14.32[c]
LSD 5%	1.40
Fertilizer N:	
Fertilizer N 55.47 kg ha^{-1}	10.86[a]
Fertilizer N 110.94 kg ha^{-1}	11.44[ab]
Fertilizer N 166.41 kg ha^{-1}	13.63[c]
Fertilizer N 221.88 kg ha^{-1}	12.47[bc]
LSD 5%	1.50

Note: Numbers accompanied by the same letter in the same column show that they are not significantly different based on the 5% LSD test; ns = not significant

Table 5: Average percentage of pithy grain as the effect of Azolla green fertilizer and n fertilizer

Treatment	Percentage of pithy grain (%)
Azolla Manure:	
Azolla 1,700 kg ha^{-1}	71.46
Azolla 3,400 kg ha^{-1}	72.15
Azolla 5,100 kg ha^{-1}	74.07
Azolla 6,800 kg ha^{-1}	77.69
LSD 5%	ns
Fertilizer N:	
Fertilizer N 55.47 kg ha^{-1}	72.10
Fertilizer N 110.94 kg ha^{-1}	74.57
Fertilizer N 166.41 kg ha^{-1}	74.45
Fertilizer N 221.88 kg ha^{-1}	74.25
LSD 5%	ns

Note: Numbers accompanied by the same letter in the same column show that they are not significantly different based on the 5% LSD test; ns = not significant

Table 6: Interaction between Azolla green manure and n fertilizer on paddy crop productivity

	($t\ ha^{-1}$)			
Treatment	Fertilizer N 55.47 kg ha^{-1}	Fertilizer N 110.94 kg ha^{-1}	Fertilizer 166.41 kg ha^{-1}	Fertilizer N 221.88 kg ha^{-1}
Azolla 1,700 kg ha^{-1}	5.71[a]	6.27[bc]	6.39[bcd]	6.18[b]
Azolla 3.400 kg ha^{-1}	5.80[a]	6.53[cd]	6.60[cd]	6,47[bcd]
Azolla 5,100 kg ha^{-1}	5.83[a]	6.68[d]	7.49[ef]	6.63[d]
Azolla 6,800 kg ha^{-1}	6.35[bcd]	6.65[d]	7.84[f]	7.15[e]
LSD 5%	0.34			

Note: Numbers accompanied by the same letter in the same column and row show that they are not significantly different based on the 5% LSD test; ns = not significant

Table 7: Interaction between Azolla green manure with N fertilizer on the weight of dry paddy

	Dry-weight plant (gm^2)			
Treatment	Fertilizer 55.47 kg N ha^{-1}	Fertilizer N 110.94 kg ha^{-1}	Fertilizer N 166.41 kg ha^{-1}	Fertilizer N 221.88 kg ha^{-1}
Azolla 1,700 kg ha^{-1}	581.83[a]	587.00[ab]	595.23[ab]	671.56[ef]
Azolla 3,400 kg ha^{-1}	597.42[ab]	611.71[bc]	630.27[cd]	680.81[f]
Azolla 5,100 kg ha^{-1}	606.49[abc]	580.03[a]	611.21[bc]	657.19[def]
Azolla 6,800 kg ha^{-1}	646.44[de]	661.06[ef]	863.63[h]	789.71[g]
LSD 5%	29.13			

Note: Numbers accompanied by the same letter in the same column and row show that they are not significantly different based on the 5% LSD test; ns = not significant

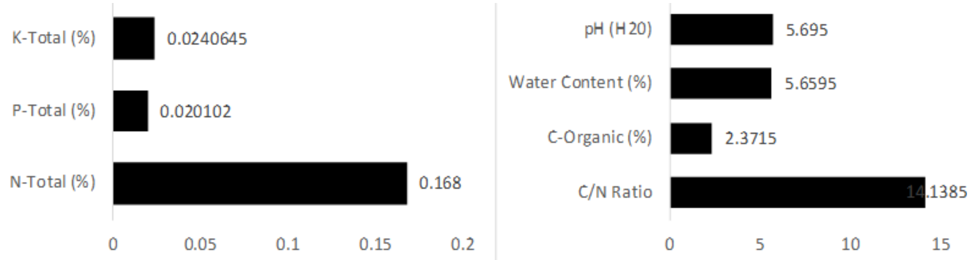

Fig. 1: Initial soil content

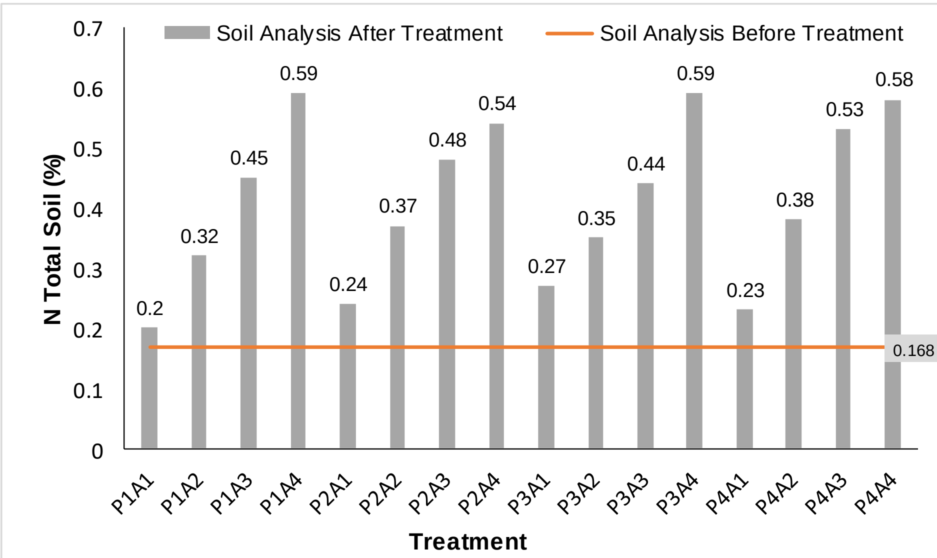

Fig. 2: Comparison of percentage of total soil N-content before and after the given treatment

Soil Analysis

The analysis of the initial and final soil state showed an increase in organic C content due to the treatment given (Fig. 1). The initial soil organic C content was 2.30% and the final soil organic C average was 4.43%. Based on Gitosuwondo (2012), about 73% of agricultural land in Indonesia contains low organic matter <2%, while the ideal range is around 2.5-4%. Based on the results of the final soil analysis, the organic C content is included in the good criteria. The increase in organic C will affect the increase in soil organic matter content.

Based on Fig. 2, The results of the analysis of organic matter content and total soil N content after treatment application showed that the use of Azolla 100% (6,800 kg ha^{-1}) had a higher content value. Thus, it can be interpreted that Azolla can increase the content of organic matter and nitrogen in lowland paddy fields.

Plant Nutrient Uptake

Based on Fig. 3, shows that the total N, P, and K value of Azolla treatment was 6,800 kg ha^{-1} which was higher at every level of urea use. Based on these results, it was found that the maximum application of Azolla and N fertilizer was able to provide the highest total N, P, and K values for plants.

Based on Table 8, shows that the yield parameters of rice plants show a positive correlation with 5 parameters such as N-total soil, C-organic soil, N-total, P-total, and K-total plants. this means that increasing the value of these five parameters will increase the yield of rice. The table also shows that the value of N-total and C-organic soil showed a positive correlation value to the N-total, P-total, and K-total plants. The increase in rice yields is obtained by increasing the nitrogen content of the soil through the application of Azolla as green fertilizer. Azolla is a floating pteridophyte that can symbiosis with the N_2 fixation cyanobacterium Anabaena azollae (Mahmudah *et al*., 2017). This is emerging as a promising approach for reducing NH_3 evaporation, increasing soil fertility, and therefore increasing NUE and grain yields (de Macale and Vlek, 2004). On the one hand, Azolla cover in paddy fields can improve soil physical and chemical conditions as well as soil microbial activity (Subedi and Shrestha, 2015) The data shown in Table 8 also shows that the higher the total nitrogen content of the soil will increase the yield grains of rice, this is because nitrogen is the most important fertilizer used in rice production and its application is very important for grain production. This is the main means of increasing rice yields (Spiertz, 2009; Qiao *et al*., 2013). Nitrogen is also an important element that forms the pigment chlorophyll in plants, so its availability can affect the rate of photosynthesis in plants. Photosynthesis is very important to achieve high or super high rice yields at the heading stage. About 90% of rice yield comes from photosynthesis and about 60-80% of yield comes from photosynthetic products after heading (Gu *et al*., 2012; Zhang *et al*., 2019). The effect of nitrogen on rice yields was also found in a study conducted by Zhang *et al*. (2022) who explained that the higher rice yield in RR rotation was caused by higher soil nutrient content (especially total nitrogen and available nitrogen) and higher organic matter.

The use of organic manure such as Azolla can be an effort to increase the availability of N (Yao *et al*., 2018). Kime (1998) stated that Azolla was able to provide 22-40 kg N/ha per month and was able to fix nitrogen in the air by 52-99% to make it available for plants. Furthermore, it was stated that Azolla which grows along with paddy plants can meet the nitrogen needs of paddy through the nitrogen fixation process (Ito and Watanabe, 1985). Based on Fig. 4, show that application azzola at higher doses shows higher N, P and K content as well. Azolla can increase the total N, P, and K values in soil and plants (Suryati and Anom, 2015).

The application of Azolla can increase the organic matter content in the soil so that microbial activity can increase and help release K nutrients bound in the soil. As green manure, Azola can improve soil properties and increase soil microbial population, thereby increasing soil fertility and rice yields (Kollah *et al*., 2016). In the decay process of Azola during the mid-growth stage, Azola-N is released and a large amount of available N is absorbed by rice plants, therefore, promoting dry matter accumulation and increased grain yield (Guo *et al*., 2019). Continuous reduction of single N fertilizers can lead to nutrient deficiency in the soil and therefore increase the risk of decreasing the efficiency of N use and yield (Xue *et al*., 2014). Azola can increase soil nutrients, improve soil properties and increase soil microbial populations (Zhang *et al*., 2020). Thus, combining reduced N fertilizers and Azola fertilizers can maintain the stability of grain yields in the long term.

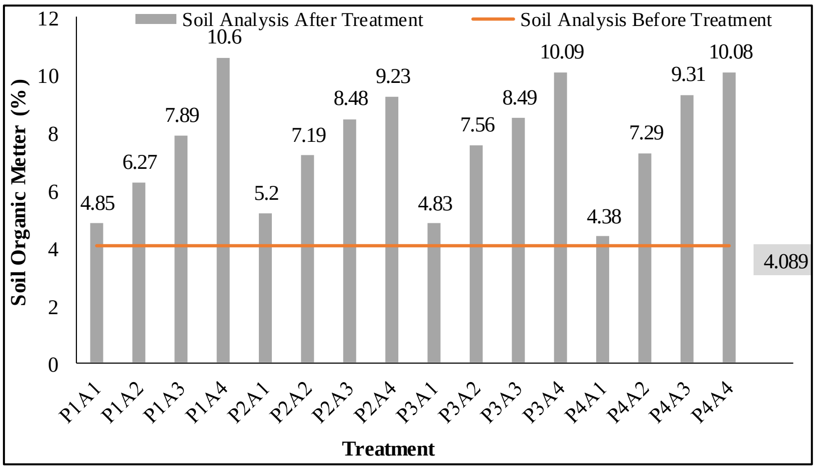

Fig. 3: Comparison of the percentage of soil organic matter content before and after treatment applications

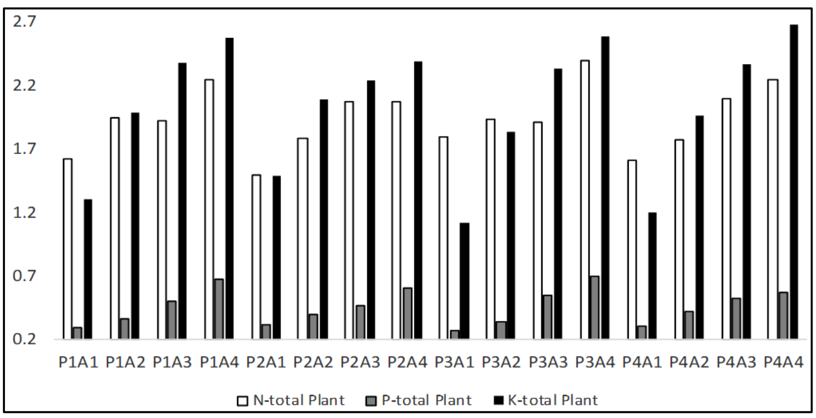

Fig. 4: N, P, and K content in plants after harvesting

Table 8: Correlation matrix between N-total soil, soil C-organic, soil water content, N-total plant, P-total plant, K-total plant, and yield

Correlations	N-total soil (%)	Soil C-organic (%)	Soil water content (%)	N-total plant (%)	P-total plant (%)	K-total plant (%)	Yield (t ha^{-1})
N-total soil (%)	1	0.975**	0.134	0.923**	0.945**	0.939**	0.605*
C-organic (%)		1	0.118	0.900**	0.935**	0.957**	0.626**
Soil water content (%)			1	0.105	-0.012	0.024	0.123
N-total plant (%)				1	0.864**	0.841**	0.600*
P-total plant (%)					1	0.905**	0.625**
K-total plant (%)						1	0.531*
Yield (t ha^{-1})							1

Note: If numbers in the table begin with a minus (-) it means there is a negative correlation, **Correlation had significantly different at the level of 0.01, *Correlation had significantly different at the level of 0,05 and ns means not significantly different

Conclusion

Based on the research results, Azolla green manure and N fertilizer in general can affect the components of plant growth in length, leaf area, number of tillers, plant dry weight, and plant nutrient uptake. The use of 6,800 kg ha^{-1} is the highest dose level capable of providing a good response to plants and soil in lowland paddy fields, the optimal productivity that can be produced from the use of Azolla 6,800 kg ha^{-1} is 7.84 t ha^{-1}.

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Author's Contributions

Setyono Yudo Tyasmoro: Conceptualization of research work, designed of experiments, and preparation of the manuscript.

Akbar Saitama: Execution of field/lab experiments and data collection. Analysis of data and interpretation.

Ethics

This article is the original work of the authors and has not been published anywhere.

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