Application of *Azolla mycrophylla* in combination with chicken manure to initiate rice organic farming in sandy soil

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Abstract. Organic agriculture needs to be continuously developed, in anticipation of climate change and the availability of inorganic fertilizers Therefore, it is necessary to look for local various organic matter that is potential and affordable to farmers. This study aims to determine the effect of *Azolla mycrophylla* (AM) and chicken manure (CM) on the growth of rice cultivated organically in sandy soil. The pot research used a factorial completely randomized design with 2 factors, the first factor was 4 levels of *Azolla mycrophylla*, namely, 0, 50, 100, and 150 tonnes ha⁻¹. The second factor is chicken manure at a rate of 0, 20, and 40 tonnes ha⁻¹. *Azolla mycrophylla* and chicken manure were given 2 weeks before planting. The results showed that there was an interaction between AM and CM on plant height, number of leaves, and number of tillers. At the age of 84 days after planting, the highest plant height, leaf number, and a number of tillers were found in the treatment of AM 50 tonnes ha⁻¹ and chicken manure 20 tonnes ha⁻¹. The use of *Azolla mycrophylla* 50 tonnes ha⁻¹ is equivalent to reducing Urea fertilizer by 261 kg ha⁻¹ or equivalent to N in the amount of 120 kg ha⁻¹.

1. Introduction
Climate change has a significant impact on food availability. Drought can reduce food products, especially in areas whose water sources depend on the reservoir, as well as excessive flooding will disrupt cultivation, production, and food distribution activities. Various efforts need to anticipate these conditions. One of them is to utilize sub-optimal land such as sand land accompanied with feasible management to give the high production.

The nutrients contents and ability to hold low water in sandy soil are low. One alternative to overcome is the use of organic matter, especially the local source of organic matter. Adding organic matter in sandy soil can improve the ability of soils to hold water as well as a source of nutrients [1, 2, 3]. *Azolla* is a water plant that can be used as organic fertilizer and is able to bind N from the atmosphere [4]. The use of *Azolla* gave a significant influence on the results of corn yields [5], rice yield [6], increases the rice yields equivalent to using fertilizers n around 60 - 80 kg N ha⁻¹ [7].

In addition, chicken manure is also one of the organic fertilizers that is widely used, easy to get, and the price is cheap. As organic matter, its use is expected to be able to improve soil fertility and plant yield [8, 9]. The research results showed that the use of 10 tonnes ha⁻¹ of chicken manure was able to increase plant height and the amount of steam in potatoes [10]. As well as a very real investment of plant height, the number of leaves, and stem diameter 20 days after planting [11]. The results of the research have been conducted showed that the use of 10 tonnes ha⁻¹ of chicken manure was able to increase plant height and the amount of steam in potato plants [10], plant height, the number of leaves, and stem...
diameter 20 days after planting [11]. However, information about its use in sandy soils is still very limited. This study aims to determine the effect of *Azolla mycrophylla* (AM) and chicken manure (CM) on the growth of rice cultivated organically in sandy soil.

2. Materials and method

This pot research used sandy soil from Bantul Yogyakarta and used a completely randomized design (CRD) factorials from 2 factors with and 3 replications. The first factor was fresh *Azolla mycrophylla* with 4 levels, namely: 0, 50, 100, and 150 tonnes ha\(^{-1}\), and the second factor is chicken manure with 3 levels, namely: 0, 20, and 40 tonnes ha\(^{-1}\). This study used the Inpari 32 rice variety planted after 14 days of incubation of *Azolla mycrophylla*. The agronomic parameter observed included plant height, number of leaves, number of tillers, and soil pH. The data were analyzed by ANOVA (Analysis of variance) followed by Duncan Multiple Range Test (DMRT) with a level of 5% and a correlation test was carried out to determine the closeness of the relationship between the observed variables.

3. Result and discussion

3.1. Result

The results of the analysis of variance showed that the effect of *Azolla microphylla* has no significant effect on plant height, in all observation times (Table 1). The adding of fresh *Azolla microphylla* up to a level of 150 tonnes ha\(^{-1}\) has not had a significant effect on plant height from 14 to 84 days after transplanting (DAT). The application of chicken manure (CM) with increasing doses had a very significant effect on plant height, at all ages of observation (Table 1). Likewise, there was a significant interaction between *Azolla microphylla* and CM except at age 24 and 42 DAT.

![Table 1. Variant analysis of the effect of *Azolla microphylla* (AM) and chicken manure (CM) on several parameters.](image-url)

The growth of rice plant growth continues to increase in line with the increasing age of the plant. The pattern of plant height increase was almost the same for all the treatments tested (Figure 1). The increase in plant height at the beginning of the observation period was not too high. Between the ages of 28 to 70 DAT, there is a significant increase in plant height.
Figure 1. Plant height by giving *Azolla mycrophylla* and chicken manure at various plant ages.

At the age of 14 DAT, using *Azolla mycrophylla* 50 tonnes ha$^{-1}$ with 40 tonnes ha$^{-1}$ of chicken manure on sandy soil showed the lowest plant height, while at 84 DAT, the highest plant height was seen in giving *Azolla mycrophylla* 100 tonnes ha$^{-1}$ with 20 tonnes ha$^{-1}$ CM. (Table 1, Figure 1). The rate of increase in plant height ranges from 0.4 to 1.0 cm day$^{-1}$. The treatment of 50 tonnes ha$^{-1}$ of AM and 20 tonnes ha$^{-1}$ of CM showed the largest plant height increasing rate of 1.0 cm day$^{-1}$ and increased by 49% compared to the control (A1M1). 0.4 to 1.0 cm day$^{-1}$. The treatment of 50 tonnes ha$^{-1}$ of AM and 20 tonnes ha$^{-1}$ CM showed the highest plant height.

No significant effect of *Azolla microphylla* on leaves number at all plant ages, but the application of CM had a very significant effect on the number of leaves, except at the age of 14 DAT. Meanwhile, the significant interaction between *Azolla microphylla* and chicken manure on leaves number was only found at the age of 84 DAT. At the beginning of growth until the age of 42 DAT, it was seen that the addition of leaves was slow in all treatments (Figure 2), and the same increase occurred until the age of 70 DAT, then the number of leaves decreased until the age of 84 DAT. In the control treatment, it was seen that the number of leaves tended to decrease with increasing plant age.

Figure 2. The number of leaves at various ages of the plant.

The results of the analysis of variance showed that there was no effect of AM on the tiller's number, while chicken manure had a significant effect on all plant ages. The interaction between AM and CM was significant at age 24 and 84 DAT (Table 1). At the age of 14 DAT, there were no additional tillers
in all treatments. At the age of 28 days, there was an increase in the tillers number except for control treatment (data not shown) and the increase was rather slow until the age of 42 DAT.

![Tiller Number](image.png)

**Figure 3.** The number of tillers at various ages of the plant.

The pattern of increase in the number of tillers is similar to the pattern of increase in the number of leaves until the age of 70 DAT the tiller numbers increase and then decrease until at 84 DAT. The number of tillers at the age of 84 DAT ranged from 3 to 17 every pot (Table 1; Figure 3). *Azolla mycrophylla* 50 tonnes ha\(^{-1}\) and CM 20 tonnes ha\(^{-1}\) and AM 100 tonnes ha\(^{-1}\) and CM 20 tonnes ha\(^{-1}\) showed the highest number of tillers, with an increase of about 373% compared to control.

The application of *Azolla mycrophylla* and chicken manure independently did not significantly affect soil pH, likewise there was no interaction between the two on soil pH. Soil pH ranges from 6.9 to 7.6 (Table 2). The highest pH was seen in the treatment of AM 50 tonnes ha\(^{-1}\) and CM 20 tonnes ha\(^{-1}\) with an increase of about 7.04%.

| Treatments | Plant height | Leaves number | Tiller number | Soil pH |
|------------|--------------|---------------|---------------|---------|
| A0M0       | 68.0a        | 3.33a         | 0.33a         | 7.1     |
| A0M1       | 93.9cd       | 33.67abc      | 7.00 abcde    | 7.5     |
| A0M2       | 78.3ab       | 15.33ab       | 3.33ab        | 7.3     |
| A1M0       | 86.8bc       | 16.33ab       | 3.67ab        | 6.9     |
| A1M1       | 92.17cd      | 57.00c        | 12.67d        | 7.6     |
| A1M2       | 76.17ab      | 27.00abc      | 5.33abc       | 7.0     |
| A2M0       | 82.83 bc     | 39.67bc       | 8.00bcd       | 6.9     |
| A2M1       | 101.00d      | 51.67c        | 12.33cd       | 7.2     |
| A2M2       | 76.17ab      | 19.33ab       | 3.67ab        | 7.2     |
| A3M0       | 90.87cd      | 32.00abc      | 6.67abcde     | 7.1     |
| A3M1       | 85.17bc      | 27.33bc       | 5.33abc       | 6.9     |
| A3M2       | 85.83bc      | 35.67bc       | 8.00bcd       | 7.0     |

Note: The means followed by the same letters in the same column indicate no significant difference according to DMRT (α= 5%): A0= without *Azolla mycrophylla*; A1= *Azolla mycrophylla* 50 tonnes ha\(^{-1}\); A2= *Azolla mycrophylla* 100 tonnes ha\(^{-1}\); A3= *Azolla mycrophylla* 150 tonnes ha\(^{-1}\); M0= chicken manure 0 tonnes ha\(^{-1}\); M1= chicken manure 20 tonnes ha\(^{-1}\); M2= chicken manure 40 tonnes ha\(^{-1}\).
3.2. Discussion
The use of fresh *Azolla mycrophylla* at a dose of 50,100 and 150 tonnes ha$^{-1}$ in sand soil has not had a significant effect on plant height, the number of leaves and the number of tillers at various plant ages. This is due to the fact that giving azolla in its fresh form to sandy soil has not provided all the nutrients needed by rice plants. *Azolla* is an aquatic plant that is able to anchor N from the air [3] so that if it is used as a fertilizer alone it only supplies N, while other elements are not fulfilled. Similar results were also found in research Maswada et al. [5] which showed that *Azolla* use only reduced urea use but had no effect on maize yield. Different results were reported by Oyange et al. [6] where giving *Azolla*. On irrigated sawh can increase grain weight, % of content and grain yield, and other inputs are needed to get a real effect from *Azolla* [12]. Plant height, number of leaves and number of tillers number were low in the control treatment. It prove that the sandy soil used as a medium is not sufficient to supply nutrients for plant growth. This result is in line with [1].

The application of chicken manure significantly increased plant height at all planting ages, but at the beginning of growth, there was no visible effect of the treatments on the number of leaves and number of tillers. This is because the chicken manure as organic fertilizer must be decomposed before releasing nutrients into the soil. Chicken manure, is an organic fertilizer that is easy to find and provides several benefits to the soil. Such as increasing the N supply [13], availability of P, micronutrients and soil moisture [14]. Improving soil structure [15], increasing the buffer capacity to drastic pH changes, increasing the soil organic matter content [3, 14]. The results obtained in this study are in line with [11] that is the use of chicken manure significantly increased plant height, number of leaves and stem diameter at the age of 20 days after planting, and increasing sorghum yield [15].

Application of *Azolla mycrophylla* and chicken manure significantly increased plant height, number of leaves and number of tillers of rice plants planted in sandy soil. This is because *Azolla mycrophylla* has the ability to giving N to the soil as much as 1.2 kg N day$^{-1}$, so it can reduce to doses of N fertilizer to soil [3]. Nitrogen is an element that has a very important role in plant growth such as plant height and leaf [16, 14] then the leaves will carry out photosynthesis to form various plant growth organ such as tillers number. On the other hand while the chicken manure contains complete nutrients [14], that it can increase soil N, P and soil fertility soil [13].

At the beginning of growth, no significant interaction effect was seen, this is because the nutrients in *Azolla mycrophylla* and chicken manure have not been released into the soil. So the plant nutrient needs have not been fulfilled. According to Jumadi et al. [17] that soil incubated with new *Azolla* showed high NO$_3^{-}$ levels within one week after incubation and lower NH$_4^{+}$ levels compared to Urea fertilizer. Likewise, the chicken manure given has not all decomposed. At the age of 42 onwards, there is a marked increase in plant height, tiller numbers and number of leaves, because the nutrients needed by rice plant are available The results of the correlation analysis showed that the number of leaves had a very significant correlation with plant height (R = 0.649, p < 0.01) and the number of tillers (r = 0.692, p < 0.01). This means that the availability of nutrients from *Azolla mycrophylla* and chicken manure can stimulate plant root growth, and further leaf formation, number of tillers.

4. Conclusion
The use of *Azolla mycrophylla* and chicken manure significantly increases plant height, the number of tillers and the number of leaves on 84 DAT. Adding fresh *Azolla mycrophylla* on sandy soil up to 50 tonnes ha$^{-1}$ accompanied by chicken manure 20 tonnes ha$^{-1}$ gave the highest plant height, number of leaves and number of tillers. These results need to be developed to increase marginal soil productivity such as sand soil with an organic system to maintain food security in anticipation of climate change.

References
[1] Herawati A, Mjuiyo, Syamsiyah J, Baldan S K, Arifin I 2021 Application of soil amendments as a strategy for water holding capacity in sandy soils *IOP Conf Ser Earth Environ Sci* 724(1) 012031
[2] Herawati A, Syamsiyah J, Mjuiyo M, Rochmadulloh M 2021 Pengaruh Aplikasi mikoriza dan
bahan pembenah terhadap sifat kimia dan serapan fosfor di tanah pasir Soilrens 18(2):26–35

[3] Brady N C, Weil R R 2014 The nature and properties of soils 2014 14th Edition (Delhi: Pearson India) pp 467–473

[4] Syamsiyah J, Herdiansyah G, Hartati S 2021 Pengenalan budidaya azolla untuk mendukung pengembangan pertanian organik PRIMA J Community Empower Serv 5(1) 38–46

[5] Maswadi H F, Abd El-Razek U A, El-Sheshawy A N A, Mazrou Y S A 2020 Effect of Azolla filiculoides on growth, physiological and yield attributes of maize grown under water and nitrogen deficiencies J Plant Growth Regul 40 558–73

[6] Oyange W A, Chemining’wa G N, Kanya J I, Njiruh P N, Oyange W A, Agron I J, et al. 2019 Effects of Azolla and inorganic nitrogen application on growth and yield of rice in mwea irrigation scheme International Journal of Agronomy and Agricultural Research (IJAAR) 14(3) 1–8

[7] Subedi P, Shrestha J 2015 Improving soil fertility through Azolla application in low land rice: A review Azarian Journals 2(2) 35–9

[8] Minardi S, Haniati I L, Nastiti A H L 2020 Adding manure and zeolite to improve soil chemical properties and increase soybean yield Sains Tanah-Journal Soil Sci Agroclimatol 17(1) 1–6

[9] Fitriani T, Pangaribuan D H, Niswati A, Yusnaini S 2021 Improving nitrogen fertilizer efficiency with the addition of compost extracts to kailan (Brassica oleracea L.) plants with wick hydroponic cultivation Sains Tanah 17(2) 122–8

[10] Kantikowati E, Karya, Yusdian Y, Suryani C 2019 Chicken manure and biofertilizer for increasing growth and yield of potato (Solanum tuberosum l.) of Granola varieties IOP Conf. Ser.: Earth Environ. Sci. 393 012017

[11] Pujiastuti E S, Tarigan J R, Sianturi E, Ginting B B 2018 The effect of chicken manure and beneficial microorganisms of EM-4 on growth and yield of kale (Brassica oleracea a cephalia) grown on Andisol IOP Conf Ser Earth Environ Sci 205 012020

[12] Lestari S U, Mutryarny E, Susi N 2019 Azolla mycrophylla fertilizer for sustainable agriculture: Compost and Liquid fertilizer applications Int J Sci Technol Res 8(7) 542–7

[13] Dikinya O, Mufwanzala N 2010 Chicken manure-enhanced soil fertility and productivity: Effects of application rates J Soil Sci Environ Manag 1(3) 46–54

[14] Tisdale S L, Nelson W L, Beaton J D, Havlin J L 1993 Soil fertility and fertilizers- fifth edition of book now available (New York: MacMillan Publ. Co)

[15] Rumambi A, Kaunang W B, Pontoh C J, Tangkere E S 2019 Production and carrying capacity of super-l sorghum given different levels of chicken manure IOP Conf Ser Earth Environ Sci 399 012115

[16] Marschner H 1995 Mineral Nutrition of Higher Plants (London: Academic Press) p.605–626

[17] Jumadi O, Hiola S F, Hala Y, Norton J 2014 Inubushi K Influence of Azolla (Azolla microphylla Kaulf.) compost on biogenic gas production, inorganic nitrogen and growth of upland kangkong (Ipomoea aquatica Forsk.) in a silt loam soil. Soil Sci Plant Nutr 60(5) 722–30

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