

The Effectiveness of Organic Fertilizer Concentration on The Growth and Development of *Azolla micropylla* and *Azolla pinnata*

Selfi Aprillia Ningrum ^{a,1*}, M. Anas Dzaky ^{b,2}, Rivanna Citraing Rachmawati ^{c,3},
Muhammad Syaipul Hayat ^{d,4}

^{a,b,c} Biology Education Study Program, Universitas PGRI Semarang

^d Science Education Master Degree, Graduate School of Universitas PGRI Semarang

¹ selfiaprillia6@gmail.com*; ² m.anaszakiy@upgris.ac.id; ³ rivanna.biologi@gmail.com;

⁴ m.syaipulhayat@upgris.ac.id

*author correspondences

Informasi artikel	ABSTRAK
Article history Received November 15th, 2023 Revised December 28th, 2023 Accepted December 30th, 2023	Tanaman <i>Azolla</i> merupakan jenis paku pakuan yang mengandung protein mencapai 23-30% dan mengandung asam amino esensial yang lengkap. Kandungan ini cocok untuk alternatif pakan ikan, campuran pakan ternak maupun pupuk hijau. Pertumbuhan tanaman <i>Azolla</i> yang baik tentunya dipengaruhi oleh beberapa faktor salah satunya yaitu keberadaan unsur hara. Tujuan penelitian ini adalah untuk mengetahui efektifitas konsentrasi pupuk organik terhadap pertumbuhan dan perkembangan <i>Azolla micropylla</i> dan <i>Azolla pinnata</i> . Penelitian ini menggunakan studi literature pada beberapa artikel dengan beberapa tahapan yaitu pemilihan artikel, analisis artikel dan penulisan laporan. Teknik analisis yang digunakan dalam penelitian ini dengan menggunakan analisis isi. Analisis ini dilakukan dengan cara pemilihan, perbandingan, dan penggabungan artikel yang sesuai dengan tujuan penelitian. Hasil studi literatur ini adalah beberapa konsentrasi pupuk organik yang dapat digunakan untuk meningkatkan pertumbuhan dan perkembangan <i>Azolla</i> adalah pupuk kandang ayam 100 gram, 50 gram/10 cc, pupuk kandang kambing 42 gram/10,5 liter air, pupuk kandang sapi 42 gram/10,5 liter air, kombinasi pupuk kandang dan sapi masing-masing 21 gram/ 10,5 liter air dan pupuk kandang kuda kombinasi pupuk kandang ayam masing masing 50% gram. Pertumbuhan dan perkembangan yang baik untuk <i>Azolla pinnata</i> menggunakan pupuk kandang ayam 50 gram dan 100 gram sedangkan untuk <i>Azolla micropylla</i> dapat menggunakan kombinasi pupuk kandang sapi dan kambing masing masing 21 gram.
Kata kunci: Azolla Konsentrasi Pertumbuhan Pupuk Organik	ABSTRACT The effectiveness of organic fertilizer concentration on the growth and development of <i>Azolla micropylla</i> and <i>Azolla pinnata</i>. <i>Azolla</i> plants are a type of fern that contains protein reaching 23-30% and contains complete essential amino acids. This content is suitable for alternative fish feed, animal feed mixture, and green fertilizer. <i>Azolla</i> plant growth is certainly influenced by several factors, one of which is the presence of nutrients. The purpose of this study was to
Keywords: Azolla Concentration Growth Organic Fertilizer	

determine the effectiveness of organic fertilizer concentration on the growth and development of *Azolla microphylla* and *Azolla pinnata*. This research uses literature studies on several articles with several stages, namely the selection of articles, analysis of articles, and report writing. The results of this literature study are several concentrations of organic fertilizers that can be used to improve the growth and development of *Azolla* are chicken manure 100 grams, 50 grams / 10 cc, goat manure 42 grams / 10.5 liters of water, cow manure 42 grams / 10.5 liters of water, a combination of manure and cow each 21 grams / 10.5 liters of water and horse manure combination of chicken manure each 50% grams. Good growth and development for *Azolla pinnata* using chicken manure 50 grams and 100 grams while for *Azolla microphylla* can use a combination of cow and goat manure.

This is an open access article under the [CC-BY-SA](#) license.



INTRODUCTION

At the beginning of 2020, the world was shocked by the spread of a new virus called coronavirus (Sars-CoV). COVID-19 is a contagious disease that causes mild to severe illnesses, ranging from the common cold to MERS or SARS. The central and local governments have implemented measures to minimize the spread of the coronavirus by encouraging residents to stay home, practice social distancing, and restrict movement in and out of certain areas. These measures have reduced economic activity, including sales, which has impacted the economy, particularly small and medium-sized enterprises (SMEs). SME owners have experienced a decline in product sales, reduced capital, and disrupted distribution. According to the Ministry of Cooperatives and SMEs, approximately 37,000 SMEs have reported being severely impacted by COVID-19. Around 56 percent reported issues related to financing, 15 percent reported distribution problems, and 4 percent reported difficulties in obtaining raw materials (Rahman, 2020).

Based on Law No. 18 of 2012 on food, there are three elements that must be fulfilled to achieve food security. These three elements are availability, accessibility, and stability. These elements must be fulfilled to prevent social and economic issues. In the current era of disruption and the 4th Industrial Revolution, science and technology can provide information on the three elements of food security. The economic impact of the COVID-19 pandemic has been felt in the livestock industry, including poultry, fish, and other livestock farming. One of the issues is the rising cost of animal feed (Rianto et al., 2021; Tarigan and Manalu, 2019; Rosdiana et al., 2017).

Feed costs constitute the largest production expense, accounting for 60–70% of total production costs. In broiler farming, the feed provided is typically commercial feed produced by factories, which is expensive (Tarigan and Manalu, 2019). This affects availability and accessibility, necessitating alternative solutions to reduce feed costs. *Azolla* is a type of fern containing 23–30% protein and complete essential amino acids (Rianto et al., 2021; Tarigan and Manalu, 2019; Asrul et al., 2022). These components are beneficial for fish growth, making *Azolla* suitable as fish feed. Herbivorous fish species such as gurami, carp, tilapia, and others can be fed with *Azolla*. The use of *Azolla* as fish feed can help reduce production costs compared to commercially produced fish feed, which tends to be expensive (Rianto et al., 2021). In addition to fish feed, *Azolla* can also be used as a feed additive for livestock. With its high protein content, *Azolla* is suitable for duck, chicken, goat, and cattle feed.

The nutrients contained in *Azolla* are influenced by the nutrients in its growth medium. The presence of nutrients is crucial in the plant's metabolic process. Generally, maximum results can be achieved if all growth conditions, including nutrient concentrations, are appropriate for the growth of *Azolla pinnata*. This can be achieved through various methods, one of which is by adding organic fertilizer (Asrul et al., 2022; Arif et al., 2021; Rosdiana et al., 2017). The objective of this study is to determine the effectiveness of organic fertilizer concentrations on the growth and development of *Azolla micropylla* and *Azolla pinnata*.

METHOD

This study used a literature review of several articles. The literature review consisted of reviewing articles from previous research references. The articles obtained were then discussed and evaluated to draw conclusions. This study used several stages, consisting of: (1) Article selection. The articles analyzed were obtained from several online research platforms in Indonesian and English. The articles analyzed were related to the concentration of organic fertilizer applied to *Azolla pinnata* and *Azolla micropylla* plants. (2) Article analysis. The articles obtained were then analyzed using qualitative methods with a correlation between content and context. (3) Writing and compiling reports. The results of the analysis that have been written down can then be rewritten in the form of a systematic and structured report. The analysis technique used in this study is content analysis. This analysis is carried out by selecting, comparing, and combining so that relevant results are obtained in accordance with the research objectives.

RESULTS AND DISCUSSION

Table 1. Details of articles and journals used in *Azolla pinnata* background research

Author	Title	Journal
Tarigan, D. M. S., & Manalu, D. S. T. (2019).	Fresh <i>Azolla pinnata</i> as an Alternative Feed to Reduce Broiler Production Cost.	Journal of Agrisep: Review of Socio-Economic Issues in Agriculture and Agribusiness, 177-186.
Rosdiana, et al. (2017).	Effect of different artificial fertilizers on the abundance of <i>Azolla</i> sp.	Acta Aquatica, 4:1 (April, 2017): 33-36
Asrul et al, (2022).	Optimization of <i>Azolla</i> Growth as Livestock Rainfed by Addition of Organic Nutrients in the Growth Media.	Agrienvi. Vol 16 No 1 June 2022 : 1-5. ISSN : 1978-4562 E-ISSN : 2175-0100
Al Arif Faiz. A., Herry Susanto, H., & Pujiswanto, H. (2021).	Effect of Goat and Cow Manure on the Growth of <i>Azolla micropylla</i> .	Agrotropika, Faculty of Agriculture, Unila, 20(1), 35-41.
Rianto et al, (2021).	Training and Implementation of Alternative Feed Making for Livestock as a Support for Food Security	Journal of Siliwangi Devotion. Volume 7 Number 1 Year 2021.P-Issn 2477-6629 E-Issn 2615-4773

Table 2. Details of articles and journals used in the description of *Azolla pinnata* and its benefits

Author	Title	Journal
Tarigan, D. M. S., & Manalu, D.S. T. (2019).	Fresh <i>Azolla pinnata</i> as an Alternative Feed to Reduce Broiler Production Cost.	Journal of Agrisep: Review of Socio-Economic Issues in Agriculture and Agribusiness, 177-186.
Maulana, M., & Haniswita. (2016)	Implementation of <i>Azolla pinnata</i> Biofertilizer in Indonesian Rice Production System: Achieving Food Security for Sustainable Development	Tica, 1-6.
.	Optimization of <i>Azolla</i> Growth as Livestock Rainfed by Addition of Organic Nutrients in the Growth Media.	Agrienvi. Vol 16 No 1 June 2022:1-5. ISSN:1978-4562 E-ISSN :2175 0100
Al Arif Faiz. A., Herry Susanto, H., & Pujisiswanto, H. (2021).	Effect of Goat and Cow Manure on the Growth of <i>Azolla microphylla</i> .	Agrotropika, Faculty of Agriculture, Unila, 20(1), 35-41.
Mantang, W., Feky, R. M., & Kolondam, B. J. (2018).	Identification of Water Spikes (<i>Azolla</i> sp.) Morphologically and Molecularly Using the Rbcl Gene.	Journal of Bios Logos, 8(2), 38-44.
Ahmad, N., & Humna, T. (2021).	The Effectiveness of <i>Azolla</i> as A Waste Decomposer and Bio-Fertilizer.	Journal Appl. Res in Plant Sci, 2(1), 108- 116.
Hikmawati, Nur, Scientific, Muhammad Rasnijal. (2023).	Natural <i>Azolla</i> (<i>Azolla Pinnat</i> Feeding with Different Feed Doses to Improve Growth and Survival of Tilapia (<i>Oreochromis niloticus</i>) Fry.	Journal of Insan Tani.Vol. 2 No. 2: 235-243 October 2023 Doi : 10.1234/Jit.V2i1.E-Issn 2828-7363
Prayoga, I. I., Alvin, N., & Andri, A. (2019).	Ruzpita (<i>Azolla pinnata</i> Grass) as Nitrogen (N ₂) Binding Organic Fertilizer in Increasing Rice (<i>Oryza sativa</i>) Plant Production.	Journal of Agribusiness Sciences, 2(2), 99-102.
Mohan, G., Sharma, O., & Manjeet, K. (2020).	<i>Azolla</i> : Empowers Women Rural Farmers.	Biotica Research, 2(12), 1291-1294.
Sunaryo, D. (2020).	Optimizing the Utilization of <i>Azolla</i> Plants (<i>Azolla Pinnata</i>) as an Empowerment of Community Income Sources for Direct Cash Assistance Recipients Affected by Covid-19 in Sukaratu Village, Cikeusal District, Serang Regency.	Journal of Community Service, 1(2), 71-80.
Surdina, E., S.A. El-Rahimi, and I. Hasri. (2016).	Growth of <i>Azolla microphylla</i> with Combination of Livestock Manure.	Scientific Journal of Marine and Fisheries Students Unsyiah, 1(3): 298-306
Siagian, Gunarian, Masni Veronika Situmorang. (2021).	Effect of Feeding <i>Azolla microphylla</i> on the Growth of Dumbo Catfish (<i>Clarias gariepinus</i>).	Journal of Science and Technology.Vol.10 No 2.P-Issn: 2303-3142

Table 3. Details of articles and journals used on chicken manure concentrations

Author	Title	Journal
Hardian, M., Basuni, & Mulyadi, S. (2021).	Effect of Combination of Chicken Manure and Nitrogen on Growth and Yield of Maize in Water- Saturated Cultivation System.	Journal of Agricultural Student Science, 10(1), 1-14.
Effendi, I., & Illahi, I. (2019).	Cultivation Technique of <i>Azolla microphylla</i> in Bucket Media and Tarpaulin Ponds.	Journal of Rural and Urban Community Empowerment, 1(1), 67-71.
DwicaHYa, Nadya, et al. (2021)	Treatment Trial on <i>Azolla</i> (<i>Azolla pinnata</i> R. Br.) Growing Media at the Installation of Research and Assessment of Agricultural Technology (Ip2tp) Kayuagung.	Proceedings of Semnas Bio 2021, State University of Padang. Volume 01 2021, Page 400-411. E-Issn: Xxxx-Xxxx. Doi: https://doi.org/10.24036/Prosemanasbio/Vol1/53
Purba, J., Putu, S., & Irwan, F. (2019).	Study on the Application of Broiler Manure and Biofertilizer on the Growth and Yield of Petsai (<i>Brassica Chinensis</i> L.).	Agro Bali (Agricultural Journal), 2(2), 77-88.
Surdina, E., S.A. El-Rahimi, and I. Hasri. (2016).	Growth of <i>Azolla microphylla</i> with Combination of Livestock Manure.	Scientific Journal of Marine and Fisheries Students Unsyiah, 1(3): 298-306

Table 4. Details of articles and journals used in goat and cow manure concentrations

Author	Title	Journal
Hartatik, W. and L.R. Widowati. (2006).	Manure. In R.D.M. Simanungkalit (Eds.). Organic Fertilizers and Biofertilizers.	Manure. In R.D.M. Simanungkalit (Eds.). Organic Fertilizers and Biofertilizers. pp. 59-82.
Al Arif Faiz. A., Herry Susanto, H., & Pujisiswanto, H. (2021).	Effect of Goat and Cow Manure on the Growth of <i>Azolla microphylla</i> .	Agrotropika, Faculty of Agriculture, Unila, 20(1), 35-41.
Asrul et al, (2022).	Optimization of <i>Azolla</i> Growth as Livestock Rainfed by Addition of Organic Nutrients in the Growth Media.	Agrienvi. Vol 16 No 1 June 2022:1-5. ISSN:1978-4562 E-ISSN :2175-0100
Hardjowigeno, S. (2007).	Soil Science.	Mediatama Sarana Perkasa. Jakarta. 237 pp
Surdina, E., S.A. El-Rahimi, and I. Hasri. (2016).	Growth of <i>Azolla microphylla</i> with Combination of Livestock Manure.	Scientific Journal of Marine and Fisheries Students Unsyiah, 1(3): 298-306
Musnamar, E.I. (2003).	Liquid and Solid Organic Fertilizers, Manufacture, and Application.	Penebar Swadaya. Jakarta. 72 pp.
Rihin, Nur. (2019).	Effect of Variations in Media Salinity Levels and Ameliant Materials on the Growth of <i>Azolla microphylla</i> Kaulf.	Scientific Journal of Agriculture. Issn Print: 0216-5430. Vol. 15, No.2 Online Issn: 2301-6442

Table 5. Details of articles and journals used in horse and chicken manure concentrations

Author	Title	Journal
Suyana, J., Sudadi, Supriyadi, (1998).	Growth rate and N ₂ inhibition of <i>Azolla</i> at various irradiation intensities and inundation heights.	Research Report of Junior Lecturer. F. Agriculture UNS, Surakarta.
Lumpkin, T. A., and D. L. Plucknett. (1982).	<i>Azolla</i> as Green Manure: Use and Management in Crop Production.	Westview Press. Colorado. 230 pp.
Maftuchah, Winaya, A. (2000).	Composition of Growing Media for <i>Azolla-Anabaena Azollae</i> Association.	Center for Agricultural Biotechnology, University of Muhammadiyah Malang.
Khan, M.M. (1988).	A Primer on <i>Azolla</i> Production & Utilization in Agriculture.	Institute of Biological Sciences of the University of the Philippines. Philippines 150 pp.
Surdina, E., S.A. El-Rahimi, and I. Hasri. (2016).	Growth of <i>Azolla micropylla</i> with Combination of Livestock Manure.	Scientific Journal of Marine and Fisheries Students Unsyiah, 1(3): 298-306
Singh, P.K. (1997).	Use of <i>Azolla</i> in Rice Production in India. In <i>Irri Edition Nitrogen and Rice</i> . Los Banos.	Laguna. The Philippines. Pp. 407-419.
Watanabe, I., Berja, N. S., Rosario D. C., (1980).	Growth of <i>Azolla</i> in paddy fields as affected by phosphorus fertilizer.	Soil Sci. Plant Nutr. 26 (2): 301-307.
Rosdiana, et al. (2017).	Effect of different artificial fertilizers on the abundance of <i>Azolla</i> sp.	Acta Aquatica, 4:1 (April, 2017): 33-36

1. Description of *Azolla* and Its Benefits

Azolla pinnata is a plant that can be found in all types of rice fields in Indonesia, because *Azolla* has the ability to grow wild and can reproduce without the need for special cultivation, therefore people always consider this plant as a weed or pest in rice fields (Mantang et al., 2018). *Azolla pinnata* is part of the kingdom plantae, part of a group of heterospore ferns that are easily found in tropical and subtropical fresh waters (Maulana & Haniswita, 2016). *Azolla micropylla* is an aquatic fern that usually grows in calm waters such as lakes, ponds, rivers, and rice fields (Arif et al., 2021; Rosdiana et al., 2017).

It only develops natural vegetation in the cooler months, specifically November to April, and cannot survive in very hot environments (Ahmad & Humna, 2021). *Azolla* growing in stagnant water is considered an ideal green fertilizer for crops grown in rice fields with adjacent vegetation (Prayoga et al., 2019). The potential of *Azolla pinnata*, among others, is used as animal feed such as poultry and fish feed, besides that it is also used as a basic ingredient for organic fertilizer, both in the form of compost and liquid organic fertilizer (POC) (Sunaryo, 2020; Arif et al., 2021; Surdina et al. 2016; Tarigan and Manalu, 2019). *Azolla* can be an ideal feed for a variety of farm animals, including cattle, pigs, poultry and fish, regardless of its use or suitability as an organic fertilizer for wetland rice (Mohan, et al., 2020).

According to research by Tarigan and Manalu (2019), the best level of fresh *Azolla pinnata* use is 10% of broiler rations. Giving 10% fresh *Azolla* to broiler chickens has a significantly different impact on broiler consumption and weight gain, while the difference in conversion is not significant. In addition, the use of *Azolla pinnata* in feed can reduce or provide production cost efficiency but not significantly different from the use of commercial feed (control). Feeding 10%

Azolla can reduce feed costs to Rp 61,750 for 9.5 kg of commercial feed (9.9%) to feed 50 broilers. The affordability of *Azolla* is supported by the research of Qomarizzaman et al., 2017 which showed that *Azolla pinnata* supplementation effectively increased the weight of male mojosari ducks. Giving *Azolla pinnata* is effective and cheap at 10% to 20%.

Meanwhile, according to research by Hikmawati, et al. in 2023 the addition of *Azolla* will have a big impact because *Azolla* has a good protein content and is rich in nutrients so that it increases absolute weight and length, SGR and survival, water content and water quality in tilapia seeds. In addition, food using *Azolla* plants also has an influence on effectiveness, this can be seen from the results of research by Siagian and Situmorang, 2021 which states that the provision of different types of food causes the effectiveness of diets to be significantly different ($p > 0.05$) for the growth of dumbo catfish. The highest feed efficiency was achieved in treatment A (100% *Azolla*), while the lowest feed efficiency was achieved in treatment C (100 Hi- Pro-Vite 781-1 tablets). According to (Mufidah K, Samidjan I, 2017), the more efficient and effective the use of animal feed, the lower the feed conversion value will be due to good quality and quantity of feed.

2. Chicken Manure Concentration

Azolla plants that are good and have high protein are certainly influenced by factors that affect their growth and development. One of the factors is the concentration of nutrients. Nutrients with certain concentrations can be added during the cultivation of *Azolla* plants. These nutrients can be in the form of organic fertilizers or inorganic fertilizers. Chicken manure is an organic fertilizer that provides the main nitrogen for the soil. Chicken manure has an important role in improving the physical, chemical and biological properties of soil. It is known that the working principle of fertilizer is to stimulate and increase the population of microorganisms in the soil, such as *Azotobacter* sp. acts as a nitrogen enhancer in the soil (Purba et al., 2019). Based on the research of Dwicahya et al, 2021, morphologically the planting media containing 10 CC water mixed with 50 g KUB manure in a 50 cm diameter tray is believed to be the most stable and continuously shows the characteristics of healthy *Azolla pinnata*. The highest average fresh weight of *Azolla pinnata* was found in the water substrate mixed with 50 g KUB manure, which was 59.75 grams/tray. From both observation parameters, it was found that testing water media mixed with KUB manure is the most effective cultivation media in the cultivation process of *Azolla pinnata*, because the nutrient content in chicken manure is more complete and easily absorbed by *Azolla*.

According to (Hardian et al.2021; Surdina et al 2016) the nutrients in chicken manure are classified as complete, one of which is nitrogen of 5.12% so that the vegetative growth process of plants is not inhibited and can encourage organ growth. Vegetative growth of plants in the form of stems and leaves, resulting in a rapid increase in the number and size of *Azolla pinnata*. The high nutrient content in chicken manure is due to the mixing of solid parts (feces) of chickens with liquid feces or urine, so it is not uncommon to find chicken manure in semi-solid form. Effendi & Ilham (2019), stated that healthy *Azolla* is seen from its clean green color like a beautiful lawn and like a thick carpet and the effect of excess nutrients can make *Azolla* dark green, while if it lacks nutrients *Azolla* will be light yellow, pale white leaf edges, and thin leaves.

3. Concentration of Goat and Cow Manure

Goat manure contains more N and K than cow manure and P elements comparable to other manures (Musnamar, 2003). The advantage of cow dung is that it has a higher fiber content such as cellulose. Cow manure can bring benefits to plants, including providing macro nutrients and micro nutrients to plants (Hartatik and Widowati, 2006). Cow dung is rich in macro and micro nutrients so that it can increase the growth of *Azolla* (Rihin, 2019; Asrul et al, 2022). Based on the

research of Arif, et al. 2021, it is stated that the use of goat manure 42 grams / 10.5 liters and cows 42 grams / 10.5 liters of water and its combination with a combination rate of goat manure 21 grams / 10.5 liters of water and cows 21 grams / 10.5 liters of water can increase population growth, root length, leaf diameter, leaf greenness, wet weight and dry weight of *Azolla microphylla*. In addition, the use of a combination of 21-gram goat and 21-gram cow manure can produce the highest population compared to other treatments. Other research using cow manure with a combination is research Asrul, et al., 2022 which states that cow and chicken feces with a concentration of 5-gram feces (cow/chicken) and 15-gram feces (cow/chicken) in 1 liter of water can significantly increase the growth of *Azolla* biomass and the highest average on protein content and dry weight. Supported by research by Rihin, 2019 which states that there is an effect of cow manure ameliorant material that is very significantly different from all observation variables, cow manure ameliorant material is the best ameliorant material on the growth of *Azolla microphylla* Kaulf.

The addition of organic materials such as goat manure and cow dung can increase root growth because goat manure and cow dung are rich in phosphorus which can stimulate root growth and development. Phosphorus-deficient plants will result in slow root growth and reduced ability to absorb nutrients so as to inhibit the growth of upper plants (Hardjowigeno, 2007; Asrul et al, 2022). The results of research by Surdina (2016) show that *Azolla microphylla* absorbs nutrients in manure, so growing on media rich in phosphorus tends to increase the productivity of *A. microphylla* plants and their nitrogen-retaining activity. Anabaena *Azollae* greatly affects the growth of *Azolla* sp. because nitrogen from the fixation process will be distributed to *Azolla* sp. cells and then will be used for the growth of *Azolla* sp.

4. Concentration of Horse and Chicken Manure

Horse manure has a higher carbon and nitrogen content than cow dung so it is a source of energy for microorganisms. Based on research by Sudirna, 2016, it was found that the combined use of horse manure and chicken manure had a significant effect on the relative growth rate, biomass increase, doubling time and density of *Azolla* fungi. The combination of 50% horse manure + 50% chicken manure can increase the protein content of 25.5% in a 1x1x0.3 m size pond with a water level of 10 cm. However, the best relative growth rate of *Azolla microphylla* was observed during the 100% chicken manure treatment as the organic matter from chicken manure improved the biological properties of the soil. In addition, organic chicken manure can provide more nutrients especially N, P and K compared to other animal manure. According to Linga (2006), the nutrient content of horse manure is 0.55% nitrogen, 0.30% phosphorus, 0.40% potassium and 75% water. Horse manure does not provide many macro nutrients such as N, P and K, even though these three elements are the elements needed by *Azolla microphylla* for its growth. *Azolla microphylla* plants require a minimum P (phosphorus) concentration of 0.2 to 0.3% fresh weight for normal growth (Maftuchah et al., 2000).

Nutrient requirements for the growth of *Azolla microphylla* must be appropriate. The nutritional needs of *A. microphylla* in N are very low because *Azolla* sp. Symbiosis with *Anabaena Azollae* fixes N₂ directly in the air, if the N content is high then *A. microphylla* will be inhibited. The results of Singh (1979) showed that the use of N makes *Anabaena Azollae* cells less active because their nitrogen needs are met. P is the main nutrient that limits the growth and development of *Azolla* species (Lumpkin and Plucknet, 1982). According to (Khan, 1988; Watanabe et. al, 1980; Asrul et al, 2022), *Azolla* sp. requires P to be continuously dissolved in water for growth and development. Therefore, the need for nutrients, especially N and P, must be appropriate.

According to (Hamawi et al. 2015; Maftuchah et al., 2000), *Azolla* requires 2 ppm phosphate to achieve maximum growth. Whereas in a controlled study using manure (cow, chicken) in the research of Asrul et al, in 2022 the content of phosphate nutrients in *Azolla* cultivation media did

not reach 2 ppm so that the tendency of Nitrogen absorption for protein formation was insufficient. As a result, there is no significant difference with the provision of cow feces with control related to the availability of nitrogen.

Rosdiana 2017 sit Suyana et al., (1998) suggests that *Azolla* sp. will grow well if sufficient nutrients are available in the growing environment. This is also supported by comments (Watanabe et. al, 1980) indicating that *Azolla* sp. is a plant that requires nutrients for its life, such as micro and macro nutrients to grow but not too high and not too low. Threshold concentrations of nutrients P, K, Mg, Ca are 0.03; 0.04; 0.04; and 0.5 mmol/liter, respectively.

CONCLUSION

Based on the literature review conducted several concentrations of organic fertilizers that can be used to improve the growth and development of *Azolla* are 100-gram chicken manure, 50 grams/10 cc, goat manure 42 grams/10.5 liters of water, cow manure 42 grams/10.5 liters of water, a combination of manure and cow each 21 grams/10.5 liters of water and horse manure combination of chicken manure each 50% grams. Good growth and development for *Azolla pinnata* using chicken manure 50-gram and 100-gram while for *Azolla microphylla* can use a combination of cow and goat manure 21 grams each.

REFERENSI

- Ahmad, N., & Humna, T. (2021). The effectiveness of *Azolla* as a waste decomposer and bio-fertilizer. *Journal Appl. Res in Plant Sci*, 2(1), 108- 116. <https://doi.org/10.38211/joarps.2021.2.1.14>
- Al Arif Faiz. A., Herry Susanto, H., & Pujisiswanto, H. (2021). Effect of goat and cow manure on the growth of *Azolla microphylla*. *Agrotropika Faculty of Agriculture Unila*, 20(1), 35-41. <https://doi.org/10.23960/JA.V20I1.4740>
- Asrul, & Ndolu Devi A.J. Optimization of *Azolla* growth as livestock forage with the addition of organic nutrients in the growing media. *Agrienvi*. Vol 16 No 1 June 2022:1-5.ISSN:1978-4562 E-ISSN : 2175-0100. <https://e-journal.upr.ac.id/index.php/aev/article/download/5027/3535/12326>
- DwicaHYa, Nadya, et al. (2021). Treatment trial on *Azolla* (*Azolla pinnata* R. Br.) growing media at the installation of research and assessment of agricultural technology (IP2TP) Kayuagung. *Proceedings of Semnas Bio 2021, State University of Padang*. Volume 01 2021, Page 400-411.E-Issn: Xxxx-Xxxx. <https://doi.Org/10.24036/Prosemnasbio/Vol1/53>
- Effendi, I., & Illahi, I. (2019). *Azolla microphylla* cultivation technique in bucket media and tarpaulin ponds. *Journal of Rural and Urban Community Empowerment*, 1(1), 67-71. <https://www.neliti.com/publications/325832/teknik-budidaya-Azolla-microphylla-pada-media-ember-dan-kolam-terpal>
- Gustiawan, D. (2019). Effect of manure type and dose of nitrogen fertilizer on growth and yield of groundnut. *Thesis*, Lampung: College of Agricultural Sciences Dharma Wacana Metro. <https://www.neliti.com/publications/325832/teknik-budidaya-Azolla-microphylla-pada-media-ember-dan-kolam-terpal>

- Hardian, M., Basuni, & Mulyadi, S. (2021). Effect of combination of chicken manure and nitrogen on growth and yield of maize plants in water-saturated cultivation system. *Journal of Agricultural Student Science*. 10(1), 1-14.
- Hardjowigeno, S. (2007). *Soil Science*. Mediatama Sarana Perkasa. Jakarta. 237 pp
- Hartatik, W. and L.R. Widowati. (2006). Manure. In R.D.M. Simanungkalit (Eds.). *Organic Fertilizers and Biofertilizers*. Pages. 59-82.
- Hikmawati, Nur., Scientific, Muhammad Rasnijal. (2023). Feeding natural *Azolla* (*Azolla Pinnata*) with different doses of feed to increase growth and survival of tilapia fish seeds (*Oreochromis Niloticus*). *Journal of Insan Tani*. Vol. 2 No. 2: 235-243 October 2023.
<https://doi.org/10.1234/Jit.V2i1.E-Issn 2828-7363>
- Khan, M.M. 1988. A Primer on *Azolla* production & utilization in agriculture. *Institute Of Biological Sciences of The University of The Phillippines*. Phillippines 150 pp.
- Lumpkin, T. A., and D. L. Plucknett. 1982. *Azollaas green manure: use and management in crop production*. Westview Press. Colorado. 230 pp.
- Maftuchah, Winaya, A. 2000. Composition of growing media for *Azolla-anabaena Azollae* association. *Center for Agricultural Biotechnology, University of Muhammadiyah Malang*.
- Mantang, W., Feky, R. M., & Kolondam, B. J. (2018). Identification of water ferns (*Azolla* Sp.) morphologically and molecularly using the Rbcl gene. *Journal of Bios Logos*, 8(2), 38-44.
- Maulana, M., & Haniswita. (2016). Implementation of *Azolla pinnata* biofertilizer in indonesian rice production system: Efforts to achieve food security for sustainable development. *Tica*, 1-6.
- Mohan, G., Sharma, O., & Manjeet, K. (2020). *Azolla: Empowers Women Rural Farmers*. *Biotica Research*, 2(12), 1291-1294.
- Mubarok, H., Rianto, R., Aradea, A., & Widiyasono, N. (2021). Training and Implementation of alternative feed making for livestock as a support for food security. *Siliwangi Devotion Journal*, 7(1)
- Mufidah K, Samidjan I, P. (2017). Effect of different frequency of commercial feed using recirculation system with activated charcoal filter on growth and survival of patin fish (*Pangasius Hypophthalmus*). *Journal of Aquaculture Management and Technology*, 6, 133-140.
- Musnamar, E.I. 2003. *Liquid and solid organic fertilizers, manufacture, and application*. Penebar Swadaya. Jakarta. 72 pp.
- Prayoga, I. I., Alvin, N., & Andri, A. (2019). Ruzpita (*Azolla pinnata* Grass) as nitrogen (N₂) binding organic fertilizer in increasing rice (*Oryza sativa*) plant production. *Journal of Agribusiness Sciences*, 2(2), 99-102. <https://jurnal.umsu.ac.id/index.php/JASc/article/view/3217/0>
- Purba, J., Putu, S., & Irwan, F. (2019). Study of broiler manure and biofertilizer application on the growth and yield of petsai (*Brassica chinensis* L.). *Agro Bali (Agricultural Journal)*, 2(2), 77-88. <https://doi.org/10.37637/ab.v2i2.417>
- Qomarizzaman, Ridho Aka, et al. (2017). The effect of *Azolla pinnata* addition in rations on weight gain of male Mojosari ducks and business analysis. Volume I, No. 2, October 2017 Issn: 2549-4686 (Online) <http://Journal2.Um.Ac.Id/Index.Php/Jih/Index>
- Rihin, Nur. (2019). The effect of variations in media salinity levels and ameliant materials on the growth of *Azolla micropylla* Kaulf. *Scientific Journal of Agriculture*. ISSN Print: 0216-5430. Vol. 15, No. 2 Online Issn: 2301-6442

- Rianto *et al.*, (2021). Training and implementation of alternative feed making for animal husbandry as a support for food security. *Siliwangi Devotion Journal*. Volume 7 Number 1 Year 2021.P-Issn 2477- 6629 E-Issn 2615-4773
- Rosdiana, *et al.* (2017). Effect of different artificial fertilizers on the abundance of *Azolla* sp. *Acta Aquatica*, 4:1 (April, 2017): 33-36
- Siagian, Gunarian, Masni Veronika Situmorang. (2021). The effect of feeding *Azolla* microphylla on the growth of dumbo catfish (*Clarias Gariepinus*). *Journal of Science and Technology*. Vol.10 No 2.P-Issn: 2303- 3142. <https://doi.org/10.23887/jstundiksha.v10i2.40231>
- Singh, P.K. (1997). *Use of Azolla in Rice Production in India*. In *Irrigation Nitrogen and Rice*. Los Banos. Laguna. The Philippines. Pp. 407-419.
- Sunaryo, D. (2020). Optimizing the utilization of *Azolla* plants (*Azolla Pinnata*) as an empowerment of community income sources for direct cash assistance recipients affected by covid-19 in sukaratu village, cikeusal district, serang regency. *Humanism: Journal of Community Service*, 1(2), 71-80. <https://journal.um-surabaya.ac.id/index.php/HMN/article/view/5487/3074>
- Surdina, E., S.A. El-Rahimi, and I. Hasri. 2016. Growth of *Azolla microphylla* with a combination of livestock manure fertilizer. *Scientific Journal of Marine and Fisheries Students Unsyiah*, 1 (3): 298-306. <https://jim.usk.ac.id/fkp/article/view/1577>
- Suyana, J., Sudadi, Supriyadi, 1998. *Growth rate and N₂ inhibition of Azolla at various irradiation intensity and inundation height*. *Research Report of Junior Lecturer*. F. Agriculture UNS, Surakarta
- Tarigan, D. M. S., & Manalu, D. S. T. (2019). Fresh *Azolla pinnata* as an alternative feed to reduce broiler production cost. *Agrisep Journal: Review of Socio-Economic Issues in Agriculture and Agribusiness*, 177-186. <https://doi.org/10.31186/jagrisep.18.1.177-186>
- Watanabe, I., Berja, N. S., Rosario D. C., 1980. Growth of *Azolla* in paddy fields as affected by phosphorus fertilizer. *Soil Sci. Plant Nutr.* 26 (2): 301-307. <https://doi.org/10.1080/00380768.1980.10431212>