AJARCDE
ASIAN JOURNAL OF APPLIED RESEARCH FOR COMMUNITY DEVELOPMENT AND EMPOWERMENT

Journal home page: http://ajarcde-safe-network.org ISSN 2581-0405

The Effect of Applying Azolla Liquid Organic Fertilizer in the Growth of Oil Palm Seedlings in Pre-Nursery

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ARTICLE INFO

Article History:
Received: 24 December 2023
Final Revision: 19 January 2024
Accepted: 19 January 2023
Online Publication: 21 January 2024

KEYWORDS

POC Azolla, concentration, oil palm seeds

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A B S T R A C T

The development and replanting of smallholder oil palm is rapid and massive; its success from the beginning is determined, among others, by sufficient quantities of seeds with good quality. Nutrient management is the highest priority in nurseries, and along with strengthening the application of sustainability principles in the palm oil industry, alternative sources of nutrients other than inorganic fertilizers are needed. This study aimed to determine the right concentration of Azolla liquid organic fertilizer to increase the growth of oil palm seedlings in pre-nursery. The study was a single factor arranged in a completely randomized design. The studied treatment of POC Azolla concentrations of 100, 85, 75, 65, 55, 45, 35, 25, 15%, plus compost treatment of Azolla solids, NPKMg (15-15-6-4) and urea with 8 repetitions. Required seedlings (9+3) x 8 = 96 polybags. The results showed that applying Azolla POC *concentration of 15-35% and solid Azolla* compost provided the growth of oil palm seedlings in the pre-nursery, which tended to be better than inorganic fertilizers. POC in this concentration range also results in a better seedling root system, thus potentially increasing the adaptability of oil palm seedlings after being transplanted on permanent land

1. INTRODUCTION

1.1. Research Background

Palm oil is a very strategic commodity for economic, social, environmental, and regional development in Indonesia, which has an area of 16.382 million hectares. The Palm Oil Moratorium, with the target of increasing productivity and limiting area expansion, is implemented, among others, through crop rejuvenation, both by large plantations and community plantations. Procuring oil palm seeds is the first step that contributes significantly to the success of the replanting.

Oil palm breeding is carried out in the pre-nursery and main nurseries. In addition to being genetically superior, maintenance actions during these two stages determine the success of obtaining quality seeds. Watering and fertilizing are decisive activities to obtain quality seedlings. So far, inorganic fertilizers have been used for oil palm seedlings. Long-term use of inorganic fertilizers can increase soil acidity and nutrient balance and decrease soil organic matter content [1]. Meanwhile, biomass-based organic fertilizers are increasingly important in line with sustainability demands in the management of oil palm plantations.

Application of organic matter can increase carbon stocks in the soil. Increasing the content of soil organic matter can be done by applying manure or compost [2]. Applying organic matter improves the physical and chemical properties of soil and soil biological functions. In this case, manure can improve the efficiency of fertilizer uptake. Applying organic fertilisers improves soil quality, increases carbon sequestration, and mitigates atmospheric CO_2 levels [3]. To improve soil structure and nutrient cycles, using organic fertilizers such as compost can save energy compared to inorganic fertilizers [4].

Applying organic fertilizers can improve the composition and transformation of soil C to improve soil quality [5]. However, long-term application of organic fertilizers to replace inorganic fertilizers can also reduce yields, which is due to the reduction of the accumulation of dry matter and NPK nutrients during the growth period. There is no standard for the amount of organic fertilizer for various crops [6].

1.2. Literature Review

Azolla is a unique plant-cyanobacterial symbiotic system. Phytohormones modulate the interaction and have long been used as fertilizer. Azolla is the first spike whose genome has been perfectly sequenced [7,8]. The accumulation of lipids, polysaccharides, proteins, phenolic compounds, vitamins, and minerals in cells causes spikes to become a potential source of organic matter. Due to its protein and amino acid composition and ease of decomposition, biomass is suitable for use as fertilizer. Azolla biomass contains essential minerals such as 3.91% N, 0.30% P, 0.65% K, C/N 6, and 39.90% organic matter [9].

Azolla has been used as a biofertilizer in rice in Asia for several centuries [10]. Azolla is widely used as a biofertilizer in *Zizania aquatica*, *Colocasia esculenta*, *Triticum aesticum* [11]. Azolla can be used as an organic fertiliser in fresh form (green manure), dry and compost, and liquid organic fertilizer (POC). However, there is no concentration or raw dose of organic fertilizer for each plant, and the raw dose is closely related to the quality and efficiency of crop production [12].

1.3. Research Objective

The study aimed to determine the right concentration of Azolla liquid organic fertilizer to support the growth of oil palm seedlings in prenursery.

2. MATERIALS AND METHODS

This study was a single-factor experiment arranged in a completely randomized design. The treatment studied was liquid organic fertilizer (POC) Azolla microphylla, which consisted of 9 treatments, namely concentrations of 100, 85, 75, 65, 55, 45, 35, 25, and 15%, plus compost treatment of solid Azolla, NPKMg (15-15-6-4) and urea with 8 repetitions. Required seedlings (9+3) x 8 = 96 polybags. The study's results were analyzed with fingerprints, followed by Duncan's test at a real level of 5 per cent.

The seedling medium is aerosol soil that has been sifted and inserted in a polybag (15x23 cm) until it reaches 1 cm from the lip of the polybag. Azolla is composted first, then 1 kg of compost is dissolved in 2 litres of water and soaked for 14 days. Oil palm seeds from the Oil Palm Research Center. After planting 1 month, POC Azolla began to be applied with a concentration according to the treatment level, with a volume of 50 ml/seedling per application and given weekly, as well as inorganic fertilizers. Urea is given at odd weeks (5,7,9,11) with a concentration of 0.2% (2 g/l of water) as much as 50 ml/seed per application. NPKMg fertilizer is applied in even weeks (6, 8, 10 and 12) with a concentration of 0.2% (2 g / litre of water) with a 50 ml/seed volume per application. Application of solid Azolla compost fertilizer is mixed evenly with the soil in a ratio of 1 1. The growth component of seedlings is observed during prenursery (age 3 months).

3. RESULT AND DISCUSSION

The analysis showed that the application of Azolla POC had a significantly diverse effect on several components of oil palm seed growth in pre-nursery, as shown in Table 1.

Table 1. The effect of POC Azolla on plant height, number of leaves and stem diameter oil palm seedlings in pre-nursery

Treatment	Components of seedling growth		
	Plant height (cm)	Number of leaves	Trunk diameter (cm)
Liquid Fertilizer Azolla 100%	22.91 abc	4.50 abc	0.66 a
Liquid Fertilizer Azolla 85%	22.39 bc	4.25 abc	0.76 a
Liquid Fertilizer Azolla 75%	23.64 abc	4.88 a	0.76 a
Liquid Fertilizer Azolla 65%	20.34 c	4.75 a	0.63 a
Liquid Fertilizer Azolla 55%	21.96 bc	4.13 bc	0.65 a
Liquid Fertilizer Azolla 45%	22.51 bc	4.00 c	0.65 a
Liquid Fertilizer Azolla 35%	23.65 abc	4.88 a	0.76 a
Liquid Fertilizer Azolla 25%	24.70 ab	4.50 abc	0.75 a
Liquid Fertilizer Azolla 15%	23.60 abc	4.25 abc	0.62 a
Compos Azolla cauldrons	26.00 a	4.75 a	0.65 a
NPKMg-Urea	21.41 bc	4.63 ab	0.66 a

Information : The number followed by different letters in the same column shows a real difference based on Duncan's test at a real level of 5%.

Table 1 shows that the growth components of seedlings respond differently to the treatment studied. POC Azolla 15-35% produces seeds with a height and number of leaves that tend to be greater than other concentration levels and have the same effect compared to the application of Azolla compost in solid form. There is a tendency for the application of organic fertilizers to produce better seed growth than inorganic fertilizers (control). The standard criteria for high growth of oil palm plants aged 3 months are around 20 – 25 cm with a small polybag size with several leaves of 3.5 – 4.5 strands. Based on these data, treating oil palm seedlings with liquid fertilizer and solid fertilizer has met good seedling growth standards. It is also known that applying Azolla POC at all concentration levels and in the form of solid compost resulted in a uniform oil palm seedling diameter response that was not significantly different. During pre-nursery, oil palm seedlings do not have complete stems and depend on the speed at which new midribs appear. The results of the analysis showed that the application of Azolla POC at all concentration levels, solid Azolla compost, and inorganic fertilizers had a diverse influence on seedling growth components that were found to contribute strongly to the biomass of oil palm seedlings in pre-nursery (Table 2).

Table 2. Effect of POC Azolla on fresh weight and dry weight of header, fresh weight and dry weight of oil palm seedling roots in pre-nursery

Treatment	Components of Seedling Growth			
	Fresh Title (g)	weight Dry Title (g)	weight Fresh root (g)	weight Dry weight (g)
Liquid Fertilizer Azolla 100%	4.66 a	1.27 a	1.61 abc	0.56 abc
Liquid Fertilizer Azolla 85%	5.43 a	1.45 a	2.16 ab	0.62 abc
Liquid Fertilizer Azolla 75%	5.35 a	1.48 a	1.56 abc	0.58 abc
Liquid Fertilizer Azolla 65%	4.10 a	1.14 a	1.48 bc	0.49 c
Liquid Fertilizer Azolla 55%	4.42 a	1.27 a	1.25 c	0.52 bc
Liquid Fertilizer Azolla 45%	4.79 a	1.30 a	1.80 abc	0.68 abc
Liquid Fertilizer Azolla 35%	5.63 a	1.47 a	2.38 a	0.75 a
Liquid Fertilizer Azolla 25%	5.69 a	1.47 a	2.28 ab	0.72 ab
Liquid Fertilizer Azolla 15%	4.31 a	1.21 a	1.90 abc	0.63 abc
Compos Azolla cauldrons	5.54 a	1.49 a	2.23 ab	0.72 ab
NPKMg-Urea	4.80 a	1.28 a	1.62 abc	0.49 c

Information: The number followed by different letters in the same column shows a real difference based on Duncan's test at a real level of 5%.

Table 2 shows that all concentrations of Azolla POC, solid Azolla compost and inorganic fertilizer have the same uniform effect on the fresh weight and dry weight of oil palm seedlings in pre-nursery. However, a 35% concentration produces the highest fresh and dry weights. However, there is a marked difference in response to fresh and dry weight of oil palm roots to Azolla POC concentration levels. Generally, the 15-35% liquid fertilizer concentration provides the highest fresh and dry weight compared to other levels, POC and compost, Azolla, solids, and inorganic fertilizers. Application of Azolla can improve soil physical properties, such as organic matter and nitrogen content, P availability, texture, pH and soil porosity [13]. Various amino acids (18 kinds) and minerals (9 elements) in its biomass cause Azolla to have many uses, especially as a biological fertilizer. Biomass is easily decomposed and mineralized because it has low C/N [14], and the release of nutrients, especially nitrogen, is faster [15], so it can be utilized optimally through periodic application of Azolla POC during pre-nursery.

The application of Azolla biomass, a source of organic matter, that can increase nutrient use efficiency, especially for nitrogen elements [16]. Petruccelli et al. [17] added that using Azolla biomass as a mixture of media to replace peat (peat) can improve the growth of olive seedlings.

It is also known that applying Azolla in the form of 15-35% POC and solid compost results in higher root weight than other treatment levels. These results reveal that the conditions of the seedling media applied by POC in the concentration range allow the root system to develop properly. The seedling root system responds faster if the media conditions are sub-optimal than the seedling above the soil surface [18]. Improvement of the tactile system, followed by increased cation exchange capacity due to the application of Azolla biomass, can increase the absorption of nutrients in the growing media [19] The development of oil palm roots will affect the seedlings' ability when transplanted on permanent land.

4. CONCLUSION

The application of Azolla POC concentration of 15-35% and solid Azolla compost provides the growth of oil palm seedlings in the pre-nursery, which tends to be better than inorganic fertilizers. POC in this concentration range also results in a better seedling root system, thus potentially increasing the adaptability of oil palm seedlings after being transplanted on permanent land.

 https://doi.org/10.29165/ajarcde.v8i1.369

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