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Submission date: 19-Mar-2024 07:16PM (UTC+0700)

Submission ID: 2324698331

File name: Evaluation_of_Organic_Liquid_Fertilizer.pdf (682.16K)

Word count: 3209

Character count: 15589

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To cite this article: L. Nanik and Muslihan 2021 ³ *IOP Conf. Ser.: Earth Environ. Sci.* **828** 012019

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Evaluation of Organic Liquid Fertilizer Concentration and Planting Media on Growth and Yield of Red Spinach (*Amaranthus Tricolor L.*) in Hydroponic Axis System

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Abstract. This study aimed to investigate the effect of organic liquid fertilizers (OLF) and different planting media on the growth of red spinach (*Amaranthus tricolor L.*). It was conducted in Kepuh Sari sub-village, Kepuhrejo Village, Kudu district, Jombang regency, East Java between October and November 2019. Furthermore, completely randomized design with two factors and triplicates observation was carried out. The first factor was the concentration of organic liquid fertilizer (OLF, which includes OLF 0% (K0), OLF 25% (K1), OLF 50% (K2), and OLF 75% (K3). The second factor included planting media such as 100% (M1) husk charcoal, 100% cocopeat (M2), and a mix of 50% of husk charcoal and 50% cocopeat (M3). The variables observed were plant height, number of leaves, area, stem diameter, root weight, wet and dry weight of stems and leaves. These parameters were analyzed by ANOVA and BNT test at a confidence level of 5%. The results showed that OLF 50% (K2) significantly influenced the growth of red spinach plants. Also, a mixture of 50% husk charcoal and cocopeat (M3) planting media induced a very significant effect on various observational variables.

1. Introduction

Red spinach (*Amaranthus tricolor L.*) is a cheap and popular horticultural product, which contains anthocyanins. These compounds act as antioxidants and prevent the formation of free radicals. The important nutrients in vegetable spinach are vitamin A (beta-carotene), C, riboflavin, and amino acids such as thiamin and niacin. Furthermore, spinach mostly contains calcium and iron needed to treat anemia (lack of red blood cells). It also contains other essential minerals such as zinc, magnesium, phosphorus, and potassium [1].

Agricultural technology using a hydroponics system is expected to provide an alternative to those with limited land to create a source of income from a different perspective. The prospect of hydroponic development is promising due to the increasing market demand for vegetables with minimal chemical content, climatic conditions which decrease agricultural land.

Hydroponics is a method of cultivation that uses other plant media than soil, such as pumice, gravel, sand, coconut husk, wood, or foam. Planting media are critical factors for determining the successfulness of cultivation in hydroponic systems. They may act as a handler for root growth and a mediator of nutrient solution. According to Rosliani and Sumarni [2], the shape may affect the



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absorption of nutrients by the roots, thereby alternating the yield and product quality. Furthermore, Susilo, A D and Koesniawati [3] suggested that husk charcoal media has advantages in terms of water distribution and aeration to provide better yields. According to Siswadi and Yuwono [4], planting media for husk charcoal, cocopeat, and fern stems are the best option in case of growth and yield for lettuce plants.

The hydroponic method, which uses an intermediary between nutrients and the growth medium, is known as the wick system. The role of the axis is the distribution of plant nutrients in the plant environment, and it should be noted that providing plants with nutrients or liquid organic fertilizers is vital. In addition, the axis system is a simple hydroponic method that is easily applied since it does not require a pump [5].

Goat manure contains organic matter that can be used as fertilizer. Solid manure conversion to organic liquid fertilizer (OLF) has not been widely utilized. Liquid organic fertilizers from solid manure can be stored for a long time and are more effective. Also, goat manure has higher potassium and nitrogen content when compared to cow manure [6]. It has potential as raw material for compost and is readily utilized by the community as organic fertilizer. Furthermore, it exhibits hard structure and decomposes slowly to enable the plants to grow optimally.

The alternative to process solid goat manure is a conversion into organic liquid fertilizer (OLF). Suparhun's [7] study showed that the treatment of organic goat manure from bokashi and as OLF at a dose of 15-30 ton/ha + OLF 2.5-5 cc / L produces the best growth of mustard greens (*Brassica juncea* L.).

Goat manure provision was able to provide nutrients such as N, P, and K that can be used by plants for growth. Rajiman [8] reported that the role of nitrogen is to increase plant growth, especially stems and branches. Therefore, it increases the plant height as well as the number of plant branches. According to Purwati [9], phosphorus (P) plays an important role in stimulating root growth, especially the growth of seeds and younger plants. Potassium plays a role in strengthening plant growth as well as stimulating stem growth.

This study aims to determine the effect of organic liquid fertilizer (OLF) from goat manure and evaluation of various growing media on the growth and production of red spinach (*Amaranthus tricolor* L.) Mira variety through hydroponic axis system.

2. Materials and Methods

This study was conducted from October to November 2018 in Kepuhsari sub-village, Kepuhrejo Village, Kudu district, Jombang regency, East Java with an altitude of \pm 90 m above sea level.

The materials used were red spinach seeds (*Amaranthus tricolor* L.) Mira variety, well water, goat manure, brown and granulated sugar, MOL / EM4, husk charcoal, Rockwool, cocopeat. The tools used were stationery, camera, cup, scale, drum (size 100 liter), used bottle (size 1.5 liter), flannelette, knife, scissors, label, used a plastic cup of mineral water (size 240) 25-liter jerry can, PH meter, waring, UV plastic, bamboo, ravic rope.

The synthesis of LOF was conducted by mixing 25 kg of goat manure, 2.5 kg of brown sugar, 125 g of white sugar, 500 mL of EM4, and 25 L of water in a container with a volume of 100 L. The mixing ingredients were incubated for 14 days and filtered to separate the liquid and solid parts. Only liquid form is used for the further experimental procedure.

The axis hydroponic pot can be built from wasted mineral bottles with a volume of 1.5 L and the third was cut by a scissor or cutter with a perforated lid. Furthermore, the lid was connected to the upper part of the bottle as a planting medium whereas the lower part is filled with water and nutrition for the plants (100 mL). The lower part was painted white to cover the plants from sunlight, and a small hole is needed at the upper side of the water to allow the aeration process. Finally, the bottle was filled with planting medium (husk charcoal and cocopeat) until 12 cm height.

The seeds were obtained from the sowing process and red spinach was planted after four leaves appeared within five days. The seeds were moved to the planting medium and were considered homogenous as well as straight in the axis channel.

The seeds were nursed at the age of 3 days after planting to cultivate the plants optimally. The maintenances were performed in form of OLF provision, replacing nutrition solution weekly, and protect the plants from plant disturbing organism. Weeding was also done daily to avoid the weeds that might grow around the spinach.

A completely randomized design (CRD) was performed with two factors. The first factor with 5 levels while the second was with 3 levels. Each treatment was repeated 3 times, and the first factor was the concentration of OLF from goat manure (K). It consisted of 4 levels: K0 = 0%, K1 = 25%, K2 = 50%, K3 = 75% while the second factor is the planting medium (M) with 3 levels of M1 = 100% husk charcoal, M2 = Cocopeat 100% and M3 = 50% husk charcoal - 50% cocopeat.

Observation parameters included plant height (cm), number of leaves (strands), leaf area (cm²), stem diameter (mm), wet weight (g), and dry weight (g). They were analyzed using analysis of variance (variance) with a factorial of completely randomized design (CRD). When the result gave a significant effect, a further test is conducted with the Least Significant Difference (LSD) and level of significance at 5%.

3. Results and Discussion

3.1. The effect of OLF administration and variation of growing media on the growth of red spinach through axis system hydroponic method.

The growth of red spinach (*Amaranthus tricolor* L.), a combination of goat manure provision (K), and planting media (M) are shown in table 1. The combination of goat manure administration and the variation of the planting medium had a significant effect on the growth of the red spinach (*Amaranthus tricolor* L.) from Mira of variety in all observed growth parameters. These parameters included plant height, number of leaves, leaf area, and stem diameter.

Table 1. The effect of OLF provision and planting media on the growth of red spinach (*Amaranthus tricolor* L.) through hydroponics axis system at 28 DAS (Day after seeding).

Treatment	Average Plant Height (cm)	Average Number of Leaves	Average Leaf Area (cm ²)	Rod Diameter (mm)
K0M1	5.46 a	5.73 ab	5.67 a	0.20 a
K0M2	4.93 a	5.27 a	3.46 a	0.22 a
K0M3	5.25 a	5.93 ab	7.13 a	0.22 a
K1M1	11.29 bc	9.47 d	21.06 bc	0.40 bc
K1M2	6.77 ab	7.07 b	9.06 ab	0.28 ab
K1M3	11.27 abc	9.20 cd	19.4 b	0.42 c
K2M1	7.21 ab	8.60 c	17.06 b	0.38 bc
K2M2	13.25 bc	9.13 cd	17.06 b	0.42 c
K2M3	14.22 bc	9.00 cd	19.2 b	0.40 bc
K3M1	9.33 abc	8.87 cd	15.33 b	0.36 bc
K3M2	5.75 a	6.33 ab	5.4 a	0.20 a
K3M3	11.72 bc	9.20 cd	9.4 b	0.41 bc
LSD	5.5	0.74	8.03	0.09

Note: K means the concentration of OLF from goat manure while M means the types of planting medium. Figures accompanied by the same letter combination in the same column were not significantly different according to the 5% LSD test.

The best result for plant height (14.22 cm) is obtained from the combination of K2M3 treatment, *i.e.* 50% goat manure mixed with husk charcoal and cocopeat (50%: 50%). On the contrary, the shortest plant (4.83) is obtained from the combination of KOM2 treatment, *i.e.* without OLF in 100% cocopeat planting medium.

In terms of the number of leaves, the combination of K1M1 treatment provided the highest number (9.47 pieces), *i.e.* 25 % OLF provision in 100% husk charcoal. On the contrary, the lowest number (5.27 pieces) originates from the combination of KOM2 treatment or without provision of OLF in 100% cocopeat.

Regarding the leaf surface, the highest area (21.06 cm²) provided by K1M1 treatment was the provision of 25% OLF in a mixture of husk charcoal and cocopeat (50%: 50%). The lowest value of 3.46 cm² was observed from the KOM2 treatment, *i.e.* without OLF provision in 100% cocopeat planting medium.

The best result for the stem diameter (0.42 mm) was provided by a combination of K2M3 treatment, *i.e.* provision of 50% OLF with husk charcoal and cocopeat (50%: 50%). The lowest diameter (0.2 mm) was observed from the combination of KOM1 treatment, *i.e.* without OLF provision in 100% cocopeat and K3M2 planting media as well as 75% OLF provision. The results showed that goat manure provision and planting media significantly affect the growth of red spinach in the axis system.

Regarding growth, it was suggested that plants required a sufficient supply of nutrition. The N plays a role in increasing overall plant growth, while the P element stimulates root growth. The potassium element enhances the plant strength.

Lussy et al. [10] reported that the goat manure contains N of 499.98 (ppm), P of 197.98 (ppm), and K of 1,537.50 (ppm). Also, macro-nutrients such as Mg, Ca, and S and micro-nutrients such as Fe, Zn, Cu, and Mn were also available in goat manure. Therefore, the nutrients in OLF from goat manure can be used for the growth of red spinach plants through the hydroponic axis system.

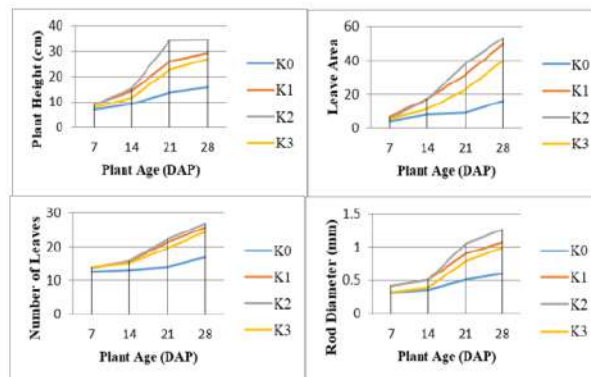


Figure 1. The growth response to OLF administration (DAP: the day after planting)

The best result of OLF treatment affects all parameters in the K2 treatment (Figure 1) such as the provision of 50% OLF from goat manure. The lowest yield on all growth observation parameters came from the treatment without giving OLF. The provision of 50% OLF contains nutrients that are ideal for the growth of red spinach plants, and it provides N, P, and K nutrients in the hydroponic axis system. These results are consistent with the study of Wibowo et al. [11] where the OLF provision increases the growth of younger plants. Similarly, in the study of Safitri et al. [12], the OLF from goat manure increases the growth of cayenne pepper plants.

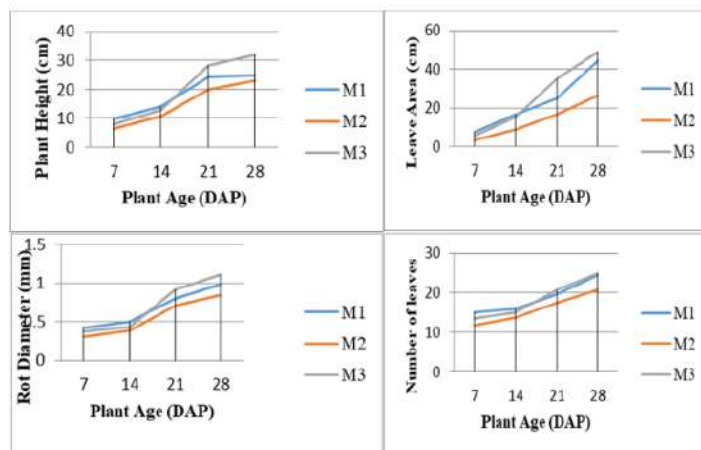


Figure 2. The growth in response to different media (DAP: the day after planting)

The best result in terms of planting media for all growth parameters was M3 (Figure 2), which consists of 50% husk charcoal and planting medium. These results are consistent with the study of Afthansia [13], where it was reported that the mixed media of husk charcoal and cocopeat provided higher yields than the single medium. Furthermore, cocopeat media provides lesser growth when compared to 100% husk charcoal. This is also consistent with Laksono's study [14], where the husk charcoal media provided a better result than the cocopeat on the pak coy plants while the 100% gave the lowest yield. This is probably due to the compounds that may affect normal plant growth. These compounds are classified as tannins and are often called anti-nutritional substances.

3.2. The effect of OLF provision and growing media on the production of red spinach using the hydroponic axis system.

The results of observing the growth of red spinach (*Amaranthus tricolor* L.) in combination with goat manure provision and planting media are represented in Table-2. The combination of goat manure provision and the planting media significantly affected the production of red spinach (*Amaranthus tricolor* L.) from Mira variety in all observed production parameters of wet and dry weight. The best results originated from the combination of K2 and M3 treatment of 10.89 g for wet weight and 5.02 g for dry. The response difference to red spinach production is due to goat manure provision and the effect of growing media as observed in Figure 3. It is suggested that M3 (50% husk charcoal and 50% Cocopeat) provided the best results for wet and dry weight (Figure 3). These results are consistent with the study of Aftahansia [13], which optimized the mixed media of husk charcoal and cocopeat to produce a higher yield.

4. Conclusion

From the results, it is reasonable to conclude that the provision of goat manure and planting media influence the growth and the yield of Mira variety red spinach (*Amaranthus tricolor* L.) in all observation parameters. Furthermore, the combination of 50% provision of goat manure in mixed planting media of husk charcoal and cocopeat provided the best results for plant height (14.22 cm), leaf area (19.2 cm), wet (10.89 gram), and dry weight (5.02 gram).

Table 2. The effect of giving OLF Goat Manure and Planting Media on the Growth of Red Spinach (*Amaranthus tricolor* L.) from Mira variety in a hydroponic axis system

	Wet weight	Dry weight
KOM1	0.78 ab	0.24 a
KOM2	0.38 a	0.07 a
KOM3	1.30 b	0.64 ab
K1M1	5.46 e	2.62 ab
K1M2	1.79 bc	0.9 b
K1M3	7.63 f	2.93 c
K2M1	9.59 g	4.76 c
K2M2	5.69 e	2.76 cd
K2M3	10.89 h	5.02 d
K3M1	4.27 d	2.11 d
K3M2	1.09 ab	0.48 ab
K3M3	4.50 d	1.88 e
LSD	0.73	0.65

Note: K means the concentration of OLF from goat manure while M means the types of planting medium and combination between them. Figures accompanied by the same letter in the same column are not significantly different according to the 5% LSD test.

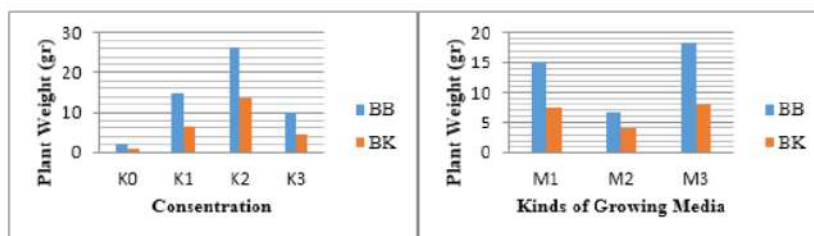


Figure 3. The production in response to OLF provision and different planting medium

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