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Drip-Applied Noni Waste Fertilizer for Improved *Allium fistulosum* Yield

Radiatul Ummah[1], Reni Ekawaty [2*]

[1]Student of the Agricultural Water Management Study Program, Politeknik Pertanian Negeri Payakumbuh, Lima Puluh Kota, West Sumatra, Indonesia
[2]Lecturer of the Agricultural Water Management Study Program, Politeknik Pertanian Negeri Payakumbuh, Lima Puluh Kota, West Sumatra, Indonesia

*Correspondence e-mail: ekawaty.reni@politanipyk.ac.id

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Abstract: Spring onion (*Allium fistulosum*), a commonly grown and economically significant vegetable utilized in various culinary applications, served as the test crop in this self-funded entrepreneurial endeavor. The discarded remnants of the noni fruit present a promising avenue for creating liquid organic plant food through a two-week microbial digestion. As a precise and water-prudent irrigation strategy, drip technology allows for the targeted delivery of moisture directly to the root systems of plants via a network of porous plastic conduits or dispensing devices. The objectives of this research were to generate liquid organic fertilizer from noni fruit waste, determine its levels of essential macronutrients—Nitrogen (N), Phosphorus (P), and Potassium (K), which were quantified at 0.11%, 0.05%, and 0.10% respectively—assess the operational effectiveness of a drip irrigation setup, and contrast the developmental patterns of spring onions nourished with a standard AB Mix nutrient solution (group A) against those receiving the liquid organic fertilizer derived from noni fruit waste. The execution of this study encompassed several stages: procurement of necessary equipment and supplies, assembly of the drip irrigation system, two evaluations of the irrigation system's functionality, production of the nutrient solution from noni waste, preparation of the growth substrate, seedling acclimatization and relocation, nutrient application, monitoring of growth indicators, and the final harvest. The outcomes of this research support the inference that discarded noni fruit can be successfully converted into a liquid organic plant nutrient solution through a two-week fermentation process facilitated by EM4 activation.

Keywords: drip irrigation system, liquid organic fertilizer, noni fruit waste, spring onion

1. INTRODUCTION

The noni plant (*Morinda citrifolia* L.), a ubiquitous species in tropical climates, including the Indonesian archipelago, presents a fruit that undergoes a color transformation from white to yellow as it ripens, typically exhibiting a round or oval morphology. Renowned for its distinctively pungent aroma and a unique flavor profile, the noni fruit has garnered significant attention for its wide array of health-promoting attributes, largely attributed to its rich reservoir of essential nutrients and bioactive compounds (Wahyudi et al., 2022). A substantial amount of noni fruit waste is generated not only from industrial processing but also from ripe, fallen fruits left to decompose naturally. This often-overlooked byproduct is a complex matrix of organic materials containing substances highly beneficial for plant cultivation. Among these are significant quantities of dietary fiber, which plays a crucial role in improving the physical structure of the soil and enhancing its drainage capabilities. Furthermore, the organic carbon present serves as a vital energy source for the diverse community of soil microorganisms, which are instrumental in the breakdown of organic matter and the subsequent enrichment of soil fertility. The inherent moisture content of noni fruit waste also contributes to maintaining optimal soil hydration levels, essential for plant vitality. Importantly, this agricultural waste stream is a natural repository of key macronutrients, including nitrogen (N), phosphorus (P), and potassium (K), all of which are indispensable for robust plant growth and development (Romiyati, 2018).

The spring onion (*Allium fistulosum*), a versatile and rapidly growing vegetable crop, holds considerable economic significance globally due to its widespread culinary applications. Its adaptability to diverse environmental conditions allows it to flourish even in space-constrained environments, such as urban agricultural initiatives. The successful cultivation of spring onions is a multifaceted process influenced by a complex interplay of environmental factors, the availability of essential soil nutrients, and the implementation of effective crop management strategies. For optimal growth and yield, spring onions have specific requirements for the primary macronutrients: nitrogen (N), phosphorus (P), and potassium (K). While estimated per-hectare nutrient requirements are in the range of 80-120 kg for Nitrogen, 30-60 kg for Phosphorus, and 60- 120 kg for Potassium, the precise quantities needed can vary significantly depending on site- specific soil characteristics and the particular cultivar being grown (Direktorat Jenderal Hortikultura, 2009; Fera et al., 2019). Understanding and meeting these nutritional demands are critical for maximizing the productive potential of spring onion cultivation. Expanding on their findings, Rosalizan et al. (2010) in highlighted the mineral content of noni fruit, which encompasses Calcium (4.13%), Sodium (1.81%), Potassium (14.00%), Iron (0.09%), Phosphorus (1.14%), Magnesium (0.081%), and Zinc (0.02%). It is widely recognized that Nitrogen (N), Phosphorus (P), and Potassium (K) are fundamental macronutrients for plant life, playing a pivotal role in facilitating their growth and development. Consequently, an insufficient supply of any single NPK element can lead to inhibited growth in plants

Chemical analyses of noni fruit waste have revealed that the concentrations of key macronutrients (N, P, and K) can exhibit variability contingent upon the prevailing soil conditions where the noni plants were grown and the specific post-harvest processing techniques employed. However, general assessments indicate that noni fruit waste typically contains a substantial percentage of nitrogen (around 5.0%), along with lower but still significant levels of phosphorus (approximately 0.25%) and potassium (around 2.5%), in addition to various essential micronutrients. Although the nutrient profile of noni fruit waste may not be as comprehensively balanced as that of commercially formulated fertilizers, its inherent nutrient content positions it as a promising alternative or supplementary resource capable of promoting improved plant growth and overall productivity (Romiyati, 2018). Exploring the potential of such organic waste streams aligns with the principles of sustainable agriculture and resource recycling.

In the pursuit of enhanced agricultural productivity, the adoption of efficient irrigation technologies, such as drip irrigation systems, has gained considerable traction. This method is recognized for its superior efficiency in the delivery of both water and essential plant nutrients. Drip irrigation operates by directly supplying water and dissolved nutrients to the active root zone of plants through an intricate network of narrow tubes strategically placed in close proximity to individual plants. This targeted delivery system offers several key advantages, including a significant reduction in water wastage through evaporation and runoff, as well as the precise application of nutrients, minimizing losses due to leaching. Furthermore, drip irrigation can play a crucial role in mitigating the risk of waterlogging, a condition that can lead to the accumulation of detrimental salts in the soil and potentially damage sensitive plant root systems. The localized application of water also contributes to improved weed management by keeping the inter-row areas drier, thereby inhibiting weed seed germination and growth (Oktoyournal, 2002). The integration of sustainable nutrient sources with efficient irrigation techniques holds significant promise for advancing agricultural practices.

Driven by the potential of noni fruit waste as a valuable resource and the efficiency of drip irrigation technology, this research endeavor was undertaken with the following specific objectives: (1) To develop and characterize a liquid organic fertilizer derived from noni fruit waste through a controlled fermentation process. (2) To quantitatively analyze the primary macronutrient content (Nitrogen, Phosphorus, and Potassium) of the produced liquid organic fertilizer to ascertain its potential as a plant nutrient source. (3) To evaluate and compare the growth performance of spring onion plants cultivated under two distinct fertilization regimes: one employing a commercially available AB Mix nutrient solution (serving as a control or standard treatment) and the other utilizing the liquid organic fertilizer derived from noni fruit waste (the experimental treatment). By addressing these objectives, this study aims to contribute valuable insights into the feasibility of utilizing agricultural waste for sustainable crop production and the effectiveness of integrating organic nutrient sources with efficient irrigation methods

2. METHOD

2.1 Time and Location

The study was conducted over a five-month period, spanning from August to December 2024. All experimental activities took place within the greenhouse facilities of the Agricultural Water Management Study Program at the Payakumbuh State Agricultural Polytechnic.

1.1. Research Methodology

This study employed an experimental design involving two distinct treatments, each replicated 30 times. The first treatment served as the control group, utilizing AB-Mix fertilizer, a commercially available hydroponic nutrient solution. The second treatment involved the application of liquid organic fertilizer derived from noni fruit waste.

1.2. Materials and Equipment

The equipment utilized in this research included a saw, hammer, nails, wooden planks, timber, buckets, pipes, pipe connectors, a valve, a drill, straws, emitters, and a blender. The materials employed were noni fruit waste, EM4 (Effective Microorganisms 4), brown sugar, well water, soil, polybags, and AB Mix fertilizer.

1.3. Drip Irrigation System Assembly

Prior to commencing the plant cultivation phase, a drip irrigation system was constructed. The assembly process involved the following steps: a raised platform, approximately 60 cm in height, was fabricated to support the nutrient reservoir buckets. A tool for perforating the lateral pipes was created using a nail and a piece of bamboo. Lateral pipes were cut to a length of 600 cm, connector pipes to 10 cm, and emitter pipes to 60 cm, with both ends of the emitter pipes sharpened. Holes corresponding to the size of the connector pipes were drilled into the lower sides of the buckets, and the connector pipes were directly attached. A valve was fitted to each connector pipe, and an end cap was placed at the opposite end of the main pipe. Lateral pipes were then connected to the end cap, extending to the far end of the experimental area. Small holes were made along the lateral pipes at intervals corresponding to the intended plant spacing, and the emitter pipes were inserted into these perforations. Pipettes were bisected, and one end of each half was pierced. Emitters were inserted into the pierced ends of the pipette halves, and straws were attached to the emitters, then inserted into the polybag media, allowing for adjustment of the drip direction. Finally, the drip irrigation system was tested by opening the valves and verifying water flow throughout all sections of the irrigation network. The drip irrigation network was then deemed complete.

1.4. Activation of EM4 Bioactivator

The following materials were required for EM4 bioactivator activation: 1 liter of EM4, 1 liter of molasses or brown sugar, and 10 liters of clean water. The activation process involved: 1. Thoroughly mixing the EM4 with the molasses or brown sugar in a large container. 2. Adding the clean water and stirring until well combined. 3. Allowing the mixture to stand for 24 hours in a shaded location to activate the microorganisms. 4. After 24 hours, the activated EM4 bioactivator was ready for use.

1.5. Production of Noni Fruit Waste Liquid Organic Fertilizer (POC)

The materials needed for POC production were: 5 kg of finely crushed noni fruit waste, 1 liter of activated EM4 bioactivator, 10 liters of clean water, and 1 kg of brown sugar dissolved in water. The production process was as follows: 1. The noni fruit waste was pulverized using a blender or by manual pounding until a fine, soft consistency was achieved. 2. The crushed noni fruit waste was then transferred to a fermentation vessel. 3. Two liters of the activated EM4 bioactivator were added. 4. The brown sugar was dissolved in 20 liters of clean water and added to the fermentation vessel. 5. All ingredients were thoroughly mixed, and the fermentation vessel was covered with a cloth or lid that allowed for air circulation. 6. The mixture was allowed to ferment for 2-3 weeks in a shaded area, with daily stirring. 7. Upon completion of the fermentation period, the solution was filtered to obtain the ready-to-use noni fruit waste POC.

1.6. Preparation of AB Mix Nutrient Solution

The required materials were: Component A (250 gr) and Component B (250 gr).

a) **Preparation of Concentration A Solution:** 1. A container with a minimum capacity of 5 liters was prepared. 2. Component A (250 gr) was dissolved in 5 liters of clean water. 3. The solution was stirred until completely dissolved. 4. The concentrated solution was stored in a sealed container.

b) **Preparation of Concentration B Solution:** 1. A 5-liter capacity container was prepared. 2. Component B (250 gr) was dissolved in 5 liters of clean water. 3. The solution was stirred until completely dissolved. 4. The concentrated solution was stored in a sealed container.

c) **Preparation of Ready-to-Use Nutrient Solution:** 1. 120 ml of Concentration A solution and 120 ml of Concentration B solution were measured. 2. These were then mixed into 12 liters of clean water. 3. The mixture was stirred until thoroughly combined. 4. The resulting nutrient solution was ready for application to the plants.

1.7. Analysis of NPK Content in Noni Fruit Waste POC

The analysis was conducted at the Soil Laboratory of the Payakumbuh State Agricultural Polytechnic. 1. A 200-gram sample was weighed, placed in a bottle, and shaken. 2. 10 ml of 25% HCl was added. 3. The mixture was then shaken using a mechanical shaker for 5 hours. 4. Subsequently, the mixture was transferred to a test tube. 5. 0.5 ml of the clear extract was pipetted and diluted with 9.5 ml of deionized water (20X dilution). 6. The diluted solution was shaken, and 1 ml was pipetted and added to a series of standards. 7. The resulting solution was transferred to a test tube. 8. 10 ml of color reagent p was added. 9. The mixture was shaken and allowed to stand for 30 minutes. 10. The absorbance was measured using a spectrophotometer at a wavelength of 693 nm.

1.8. Preparation of Planting Medium

The necessary tools and materials were gathered. Soil was used as the primary planting medium and was sieved to remove clumps before being placed in the polybags. The sieved soil was then mixed with humus soil until a homogenous mixture was obtained. This mixed soil was subsequently filled into the polybags.

1.9. Preparation of Spring Onion Seedlings

1. Mature spring onions were selected upon purchase, ensuring the roots remained intact.
2. The selected mature spring onions were weighed, totaling 2 kg.
3. Any dead or decaying leaves were removed.
4. Approximately one-third of the root length was trimmed to facilitate planting.
5. The leaf stalks were cut, leaving about 7 cm above the root.
6. The prepared spring onion seedlings (cuttings) were then ready for planting.

Transplanting Spring Onion Seedlings into Polybag Media: 1. Small holes were created in the polybags. 2. The prepared spring onion seedlings were planted in these holes. 3. Following transplanting, the plants were watered with the respective nutrient solutions by initiating the flow of the drip irrigation system.

1.10. Fertilization and Maintenance

Fertilization was applied to two treatment groups, each consisting of 30 polybags: Treatment A (AB Mix) and Treatment B (Noni Fruit Waste POC). Each treatment received a distinct nutrient solution delivered via the drip irrigation system. In Treatment A, the AB Mix solution in the first reservoir maintained a pH of 6.10 ppm for the first 14 days, 6.28 ppm from day 14 to 28, and 6.52 ppm from day 28 to 75. In Treatment B, the noni fruit waste POC in the second reservoir had a pH of 6.28 ppm for days 1-14, 6.60 ppm for days 14-28, and 7 ppm for days 28-75.

Fertilization Methods for Each Treatment:

A. Treatment A (AB Mix Fertilizer): 1. 12 liters of clean water were placed in a bucket. 2. 120 ml of Concentration A and 120 ml of Concentration B were added. 3. The solution was stirred until thoroughly mixed. 4. pH and EC measurements were taken. 5. For plants aged 1-14 days after transplanting (DAT), the pH was maintained at 6.10 and EC at 980 μS/cm. 6. For plants aged 14-28 DAT, the pH was 6.28 and EC was 1000 μS/cm. 7. For plants aged 28-75 DAT, the pH was 6.52 and EC was 1260 μS/cm. 8. The solution was added to the reservoir and allowed to flow through the drip system.

B. Treatment B (Noni Fruit Waste POC): 1. 600 ml of noni fruit waste POC (obtained from the fermentation process) was prepared. 2. This was mixed with 12 liters of clean water to create the ready-to-use nutrient solution. 3. The solution was stirred until dissolved, and pH and EC were measured. 4. For plants aged 7-14 DAT, the pH was 6.28 and EC was 980 μS/cm. 5. For plants aged 14-28 DAT, the pH was 6.60 and EC was 1000 μS/cm. 6. For plants aged 28-75 DAT, the pH was 7 and EC was 1260 μS/cm. 7. The solution was added to the fertilizer reservoir and allowed to flow.

The adjustments in pH and EC of the nutrient solutions during the study were made to accommodate the varying nutrient uptake rates of the spring onion plants at different growth stages. During the initial phase, nitrogen uptake may be higher, while subsequent phases may see increased demands for phosphorus and potassium. These imbalances can influence the pH and EC of the solution. Maintaining pH and EC within the standard range for spring onions is crucial to prevent root damage and stunted growth. Weed control within the polybags was performed manually through weeding once every seven days.

1.11. Data Processing

The following is an example of the table format used for recording observations and the formulas employed for data analysis:

- **Observation Table:** Week, pH, EC (μS/cm), Temperature (°C), Number of Leaves, Average Plant Height (cm), Average Production (g).
- **Data Processing Formulas:**
  - **Average Number of Leaves per Week:** (Total Number of Leaves of All Plants) / (Number of Plants)
  - **Average Plant Height per Week:** (Total Height of All Plants) / (Number of Plants)
  - **Average Production:** (Total Weight of Spring Onions) / (Number of Plants)
  - **pH and EC Analysis:** Create graphs of pH and EC changes over time; analyze trends to determine if pH and EC remained within the optimal range.
  - **Temperature Analysis:** Create graphs of temperature changes over time; analyze if temperature influenced plant growth.
  - **Growth Analysis:** Create graphs of average number of leaves and plant height over time.
  - **Analysis of Relationships:** Analyze the correlations between pH, EC, temperature, and plant growth.
  - **Production Analysis:** Calculate total production per plant and overall; create graphs to visualize production data.

3. RESULT AND DISCUSSION

The daily water demand of the spring onion plants was determined to be 1.75 liters per individual plant. This volume was established through the calculation of the crop's evapotranspiration (Etc) using the Cropwat 8.0 software, taking into account the spatial dimensions of the cultivation containers (polybags). As a result, each plant was supplied with 1.75 liters of water on a daily basis. The irrigation schedule involved two applications per day, occurring at 7:00 in the morning and 5:00 in the afternoon (at twelve-hour intervals).

a. Observations on Noni Fruit Waste Liquid Organic Fertilizer (POC)

Based on visual assessments, the noni fruit waste liquid organic fertilizer exhibited a brown hue and an aroma reminiscent of fermented cassava ("tape"). These characteristics suggest a successful fermentation process, aligning with established criteria for effective POC, which typically presents a brownish color and a "tape-like" scent (Ernis et al., 2021). The results of chemical parameter analyses are detailed in Table 1 below:

Table 1. Observation Parameters of Noni Fruit Waste POC

No	Parameter	Unit	Before Dilution	After Dilution (Days After Transplanting)		
				1 – 14 DAT	14 – 28 DAT	28 – 75 DAT
1	pH	-	7	6,05	6,10	6,60
2	EC	$\mu s/cm$	2100	900	1020	1170
3	Temperature	^0C	23	19	21	24

As indicated in Table 1, the initial pH of the POC before any dilution was 7. To meet the specific requirements of the plants, the POC was diluted to achieve pH levels of 6.05 for the initial 14 days post-transplant, 6.10 for the subsequent 14-day period (days 14-28), and 6.60 for the later growth stages (days 28-75). These pH values are considered highly suitable for application to plants, as the optimal pH range for POC is between 5.5 and 7.5. This range is conducive to the vitality of microorganisms within the POC, ensuring that essential plant nutrients remain available and stable for uptake by the plants (Khumaira et al., 2023).

The electrical conductivity (EC) of the undiluted POC was measured at 2100 μS/cm. According to Bayu (2016) , the ideal EC range for onion plants falls between 980 and 1260 μS/cm, necessitating dilution. Following dilution, the EC values for the different growth stages were: 900 μS/cm for 1-14 DAT, 1020 μS/cm for 14-28 DAT, and 1170 μS/cm for 28-75 DAT.

The temperature of the POC solution during the initial 1-14 DAT period was slightly below the recommended standard. However, for the later growth stages (14-75 DAT), the temperature was within the optimal range of 20-25 °C for nutrient solution absorption by plants, as suggested by (Lee et al., 2020; Samba et al., 2024). The analysis of the AB Mix fertilizer yielded the results presented in Table 2 below:

Table 2. Observation Parameters of AB Mix Fertilizer

No	Parameter	Unit	Before Dilution	After Dilution (Days After Transplanting)		
				1 – 14 DAT	1 – 14 DAT	1 – 14 DAT
1	pH	-	7	6,05	6,30	6,5
2	EC	$\mu s/cm$	3400	900	1000	1200
3.	Temperature	^0C	30	20	22,6	25

An examination of Table 2 reveals that the recorded levels of pH, electrical conductivity (EC), and temperature for the AB-Mix fertilizer exhibited no substantial variation when compared to the findings for the liquid organic fertilizer derived from noni fruit waste. As indicated by Wibowo in 2018, a pH range of 5.5 to 6.5 is considered optimal for AB-Mix solutions to ensure the stability of nutrients crucial for the development of spring onions. Furthermore, the EC values of the AB-Mix were consistent with the necessary range for spring onion growth, identified as 980 to 1260 μS/cm (Bayu, 2016). Likewise, the temperature of the AB-Mix solution satisfied the standard conditions conducive to the growth of spring onion plants

b. Macronutrient (NPK) Analysis of Noni Fruit Waste POC and AB - Mix

The quantification of Nitrogen (N), Phosphorus (P), and Potassium (K) within the noni fruit waste-based liquid organic fertilizer (POC), as determined by the Soil Laboratory at PPNP, is detailed in Table 3. To provide a basis for comparison, the NPK analysis outcomes of POC as documented in the research by Pratiwi & Hendri (2023) are presented in Table 4, as outlined below

Table 3. Macronutrient (NPK) Analysis Outcomes for Noni Fruit Waste POC

No	Analyzed Component	Measurement	Obtained Value	Value from (Pratiwi & Hendri, 2023)	Indonesian National Standard (SNI) 19-7030-2004
1.	Nitrogen	%	0,11	3,11	0,10
2	P Potensial Ekstrak HCl 25 %	%	0,05	0,49	0,10
3	K Potensial Ekstrak HCl 25 %	%	0,10	1,98	0,20

An examination of Table 3 reveals that only the nitrogen (N) concentration, recorded at 0.11%, aligned with the stipulated Indonesian National Standard (SNI). The concentrations of both phosphorus (P) and potassium (K), however, fell short of these established benchmarks. The outcomes of this study indicated a lesser yield than that documented by Pratiwi & Hendri (2023). The findings reported by Pratiwi exhibited considerable resemblance to those documented by Chunhieng et al. (2005). Specifically, the concentration of Nitrogen (N) was recorded at 3.64, Phosphorus (P) at 0.25, and Potassium (K) at 0.41 in Pratiwi's study, aligning closely with Chunhieng's observations. It is noteworthy that noni fruit possesses considerable promise as a source for liquid organic fertilizer, primarily due to its substantial levels of Nitrogen, Phosphorus, and Potassium.

c. Plant Height Assessment

The mean heights of the spring onion plants, recorded at various intervals post-transplantation, are detailed in the subsequent Table 4:

Table 4. Mean Height of *Allium fistulosum* Plants

No	Days Following Transplant (DFT)	Plant Height (cm)	
		Group A (AB-Mix)	Group B (POC)
1	14	18,53	19,26
2	21	21,30	22,13
3	28	26,45	25,43
4	35	33,76	33,34
5	42	35,71	34,86
6	49	37,57	36,55
7	56	42,61	41,47
8	63	45,30	42,67

The data presented in Table 4 indicates that the average height of the spring onion plants in both Group A and Group B showed a progression by the 14th day after transplanting. Notably, the plants in Group A generally displayed greater average heights compared to those in Group B across the observation periods. A plausible explanation for this trend could be the more adequate provision of essential nutrients in the AB-Mix treatment (Group A) relative to the nutrient availability in the POC treatment (Group B).

d. Mean Leaf Count of *Allium fistulosum* Plants

The average quantity of leaves observed on each spring onion plant is summarized in the subsequent Table 5

Table 5. Mean Leaf Count per *Allium fistulosum* Plant

No	Days Post-Transplant Observation	Mean Number of Leaves per Plant (pieces)	
		Group A (AB-Mix)	Group B (POC)
1	14	2	2
2	21	3	3
3	28	5	4
4	35	11	10
5	42	12	12
6	49	18	17
7	56	25	24
8	63	29	26

The data presented in Table 5 indicates a trend where the spring onion plants treated with AB-Mix (Group A) consistently produced a greater average number of leaves than those treated with the noni fruit waste-based liquid organic fertilizer (Group B). This observation further suggests that the more comprehensive nutritional profile of the AB-Mix fertilizer likely contributed to enhanced leaf development in the spring onion plants. The availability of sufficient nutrients is a critical factor influencing overall plant growth. Hamdani et al. (2015) pointed out that the absence or insufficient levels of N, P, and K can hinder the growth processes in plants. Expanding on this, Mawali et al. (2023) stated that organic fertilizers contribute to the enhancement of soil vitality, are involved in fermentation processes, and provide the necessary nutritional elements for plant growth

e. Average Number of Stems per Spring Onion Plant

As shown in Table 6, the number of stems in Treatment A was generally higher than in Treatment B. Consistent with the findings for plant height and leaf count, Treatment A exhibited superior growth compared to Treatment B. This further reinforces the crucial role of nutrient availability in promoting optimal plant development. The growth of stems in plants is heavily dependent on the nutrient phosphorus (P). According to the findings of He et al. (2004), phosphorus plays a significant role in the development of shoots, roots, flowers, and fruits. For this reason, phosphorus (P) is considered a fundamental essential nutrient that plants need to achieve their best growth and output.

Table 6. Average Number of Stems per Spring Onion Plant

No	Observation Days After Transplanting (DAT)	Average Number of Stems (pieces)	
		Group A (AB-Mix)	Group B (POC)
1	14	1	1
2	21	2	2
3	28	2	3
4	35	3	3
5	42	3	3
6	49	4	4
7	56	5	5
8	63	6	5

f. Mean Harvest Output of *Allium fistulosum* Plants

The average harvested mass of the spring onion plants is graphically illustrated in the subsequent Figure 1:

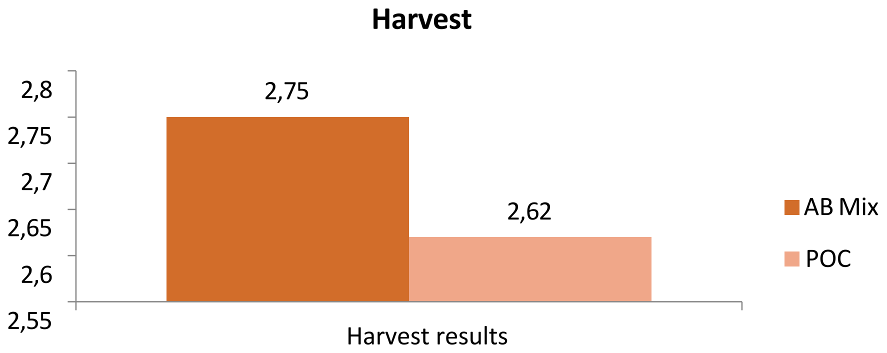

Figure 1. Comparative Harvest Yield of Spring Onion Plants

The data depicted in Figure 1 indicates a greater overall harvest weight for the spring onions cultivated with Treatment A when juxtaposed with those under Treatment B. Integrating the findings across Tables 1 to 6, it becomes evident that the nutrient composition of the administered fertilizer played a crucial role in the growth patterns of the spring onion plants. The AB-Mix solution supplied a more optimized and sufficient array of nutrients conducive to the development of spring onions when compared to the liquid organic fertilizer sourced from noni fruit byproducts.

4. CONCLUSION

The outcomes of this investigation support the inference that discarded noni fruit can be successfully converted into a liquid organic plant nutrient solution through a two-week fermentation process facilitated by EM4 activation. The resulting POC displayed a brownish coloration and an aroma similar to fermented cassava. When diluted, the POC presented a pH spectrum between 6.05 and 6.60, an electrical conductivity (EC) spanning 990 to 1170 µS/cm, and a temperature range of [Suhu tidak lengkap dalam teks]. Laboratory assays of the noni fruit waste- derived POC indicated the presence of key macronutrients at the following concentrations: Nitrogen (N) at 0.1%, Phosphorus (P) at 0.05%, and Potassium (K) at 0.10%. Comparative analysis of spring onion development revealed average ranges for plant height of 18.53 to 37.57 cm in the AB Mix-treated group (A) and 19.26 to 36.55 cm in the POC-treated group (B). The mean leaf count ranged from 2 to 29 in Group A and 2 to 26 in Group B. The average stem count varied from 1 to 6 in Group A and 1 to 5 in Group B. The mean number of clumps was consistent across both treatments at 2. The final harvested weight was 2.75 kg for the AB Mix treatment (A) and 2.62 kg for the POC treatment (B).

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