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Effects of water hyacinth compost and biological agents (*Trichoderma* sp.) on the growth and yield of shallots (*Allium ascalonicum* L.) in dry land

Laurensius Lehar*, Tri Luchi Proklamita, and Zainal Arifin

Department of Food Crops and Horticulture, State Agricultural Polytechnic of Kupang, Indonesia
Jl. Prof. Dr. Herman Johanes, Kupang City, East Nusa Tenggara, Indonesia.
*Corresponding author: laurensiusl@yahoo.co.id

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Abstract

Shallot (*Allium ascalonicum* L.) is one of leading vegetable commodities intensively cultivated by farmers for a long time, including farmers in East Nusa Tenggara (ENT). The purpose of this study was to produce water hyacinth compost with ability to interact with *Trichoderma* sp. in order to improve the shallot bulb quality cultivated in dry land. This factorial experimental research was arranged in a Split Plot Design with 10 treatments and 3 replications. There were 10 treatment combinations with 30 experimental plots. Two factors were tested in this research. The first factor was the water hyacinth compost as the main plot, namely: 15 ton ha^{-1} water hyacinth compost (K1) and without water hyacinth compost (K2), while the second factor as a sub-plot was the concentration of *Trichoderma* sp., consisting of watering with plain water (as control) of 100 mL (P0), watering with a concentration of *Trichoderma* sp. 5 $mL.L^{-1}$ (P1), watering with a concentration of *Trichoderma* sp. 10 $mL.L^{-1}$ (P2), watering with *Trichoderma* sp. concentration 15 $mL.L^{-1}$ (P3) and watering with *Trichoderma* sp. 20 $mL.L^{-1}$ (P4). The treatment of water hyacinth compost fertilizer at 15 tons ha^{-1} with a concentration of *Trichoderma* sp. 20 $mL.L^{-1}$ resulted in the highest number of shallot leaves (84.27 strands) and tillers (10.82). The shallot bulb weight per plot was 2,455.33 g, and the number of bulbs per plot was 350.40 bulbs.

INTRODUCTION

Shallot (*Allium ascalonicum* L.) offers many advantages, making it one of leading vegetable commodities with high economic value and demand. Shallot is an important cooking spice, either for home cooking, restaurants or food industry. In addition, shallots are also used as herbal medicine (Lehar et al., 2021).

Several previous studies have revealed the positive potential of water hyacinth compost in improving soil fertility and agricultural yields. The application of water hyacinth tricho-compost has a significant impact on plant height, number of leaves, number of bulbs, fresh weight, and dry weight of shallots. The optimal dose for enhancing plant height, number of leaves, number of bulbs, fresh weight, and dry weight of shallots is 400 g/polybag (Sukmasari et al., 2023; Kusrinah et al., 2016; Sianturi et al., 2021).

The application of water hyacinth compost significantly increases the soil's organic matter content and nutrient availability for plants (Sittadewi, 2007). The nutrient element present in water hyacinth compost is nitrogen (N). Nitrogen is one of the essential macro-nutrients required by plants in significant amounts. Nitrogen plays a crucial role in the vegetative growth of plants, particularly in stem development that influences plant height. Additionally, the presence of phosphorus (P) in water hyacinth organic compost stimulates cell division and elongation, contributing to an increase in plant volume, namely plant height (Septania et al., 2022; Sianturi et al., 2021).

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The highest shallot production is in Central Java Province, with 592,489 tons yield (30.49% with an area of 65,361 ha) (Central Statistics Agency of Central Java, 2020). However, shallot production has experienced a sharp increase in the last three years, namely in 2017, 2018, and 2019, with each reaching 476,337.3 tons, 445,585.5 tons, and 481,889.5 tons, respectively (Central Statistics Agency of Central Java, 2020).

The average consumption of shallots in Indonesia reached 2.76 kg per capita per year. The participation rate of household shallot consumption in Indonesia has changed every year, namely 93.34%, 92.92%, 93.08%, 92.88%, and 93.42% in 2015, 2016, 2017, 2018, and 2019, respectively (Dewi and Sutrisna, 2016). Furthermore, Dewi and Sutrisna (2016) stated that the demand for shallots would continue to increase along with population growth, the development of the ready-to-eat food industry, and market development. The increase in shallot demand represents a potential market opportunity that should motivate farmers to improve their shallot production.

Shallot production in East Nusa Tenggara (ENT) Province is still very low, 10,423.4 quintals, compared to production from other provinces (Central Statistics Agency of East Nusa Tenggara, 2020). To meet the demand for shallots, East Nusa Tenggara Province needs shallot supplies from other areas, such as West Nusa Tenggara (WNT) and East Java (Lehar et al., 2021).

The low productivity of shallots is caused by several factors, including cultivation techniques and fertilization. The low quality and quantity of shallot production can also be influenced by an inappropriate growing environment, which in this case is due to high temperatures in dry land. Such conditions make the growth of shallot plants less fertile, and there is a lack of beneficial microorganisms such as *Trichoderma* sp. (Lehar et al., 2021). Additionally, this condition also makes the plants less fertile due to inadequate nutrients available in the soil. Suprapta (2012) stated that biological agents (*Trichoderma* sp.) could enhance the growth and yield of shallot plants. Similarly, Lehar et al. (2016) also found that biological agents could proliferate in the microenvironment, enabling plants to grow free from pathogens. Moreover, biological agents also produce growth hormones called Plant Growth Promoting Rhizobacteria (PGPR) that can stimulate plant growth. This research aimed to evaluate the effects of water hyacinth compost and bio-agent (*Trichoderma* sp.) application on the growth and yield of shallots in dry land.

MATERIALS AND METHODS

This research was conducted from April–November 2021, in Lasiana Village, Kupang City, East Nusa Tenggara Province. The materials used in this study were shallot seeds of the Bima variety, water hyacinth and *Trichoderma* sp. compost, and label paper, while the tools used included hoe, shovel, bucket, fiber water reservoir, knife, plastic bag, measuring glass, scale, spray tank, ruler and stationery.

This research was arranged in a factorial experiment using a Split Plot Design with 2 treatments and 3 replications. There were 10 treatment combinations with a total of 30 experimental plots. Two factors were tested. The first factor was the water hyacinth compost as the main plot, which included 15 ton ha^{-1} water hyacinth compost (K1) and without water hyacinth compost (K2). The second factor as a sub-plot was the concentration of *Trichoderma* sp., including watering with plain water (as a control) 100 mL (P0), watering with a concentration of *Trichoderma* sp. 5 mL + plain water 95 mL (P1), *Trichoderma* sp. 10 mL + water 90 mL (P2), *Trichoderma* sp. concentration 15 mL + 85 mL plain water (P3), and *Trichoderma* sp. 20 + 80 mL plain water (P4).

The research implementation involves several steps. First, the land is cleared. Then, 30 plots are created, each measuring 2 meters by 1.20 meters with a height of 30 centimeters. The distance between treatment plots is 30 centimeters, and between replications, it is 50 centimeters. After that, water hyacinth compost is evenly spread on each plot at a rate of 6 kilograms per plot. *Trichoderma* sp. is applied two weeks before planting according to the treatment. Shallot bulbs are planted with a spacing of 20 cm x 20 cm. Each row contains 9 plants, and each plot has 4 rows of plants, resulting in a total of 36 plants per plot. The number of sample plants used is 6. *Trichoderma* sp. is applied every 2 weeks until the plants are 45 days old after planting (DAP).

Variables observed include the number of leaves (strands), counted on plants aged 2 WAP, 4 WAP, 6 WAP, 8 WAP, and 10 WAP by counting all fully open leaves. Bulb weight per plot (g) involves observing the weight of bulbs per plot conducted once at the end of the experiment (during harvest) by weighing bulb samples per plot. The number of bulbs per plot involves observing the number of bulbs per plot conducted once at the end of the experiment (during harvest) by weighing bulb samples per plot.

Data obtained from the experiment were analyzed using analysis of variance to determine the effect of each treatment. Significant differences will be tested using the Honestly Significant Difference (HSD) test at the 5% level.

RESULTS AND DISCUSSION

Number of leaves (strands)

The treatment of water hyacinth compost and *Trichoderma* sp. showed an interaction on the number of shallot leaves at the age of 6 WAP, 8 WAP, and 10 WAP. The data on the number of leaves as affected by the interaction of water hyacinth compost and *Trichoderma* sp. is presented in Table 1.

Table 1 shows that at 6 WAP, the application of water hyacinth compost with a concentration of 20 mL.L^{-1} *Trichoderma* sp. resulted in the highest number of leaves (38.20 leaves), but it was not significantly different from the treatment without water hyacinth compost and 20 mL.L^{-1} *Trichoderma* sp. However, it was significantly different from other treatments. Meanwhile, the lowest number of leaves was found in the treatment without water hyacinth compost and without 0 mL.L^{-1} *Trichoderma* sp. (21.11 leaves), but it was not significantly different from the treatment with water hyacinth compost and 0 mL.L^{-1} *Trichoderma* sp. concerning the number of leaves.

At 8 WAP and 10 WAP, the treatment of water hyacinth compost with a concentration of 20 mL.L^{-1} *Trichoderma* sp. resulted in the highest number of leaves (84.25 and 84.27 leaves), significantly different from other treatments. Meanwhile, the lowest number of leaves was found without water hyacinth compost and without 0 mL.L^{-1} *Trichoderma* sp. treatment, both at 8 WAP and 10 WAP, but not significantly different from the treatment with water hyacinth compost and without 0 mL.L^{-1} *Trichoderma* sp. concerning the number of leaves.

At the 4 WAP observation, there was no interaction between the water hyacinth compost treatment and the concentration of *Trichoderma* sp. on the variable of the number of leaves. The highest number of leaves due to the water hyacinth compost treatment at 4 WAP is presented in Table 2.

According to Table 2, at 2 WAP, the highest number of leaves was found in the treatment with a concentration of 20 mL.L^{-1} *Trichoderma* sp. (4.41 leaves), but not significantly different from the treatment with a concentration of 15 mL.L^{-1} *Trichoderma* sp., yet significantly different from other treatments. At 4 WAP, the highest number of leaves was found in the treatment with a concentration of 20 mL.L^{-1} *Trichoderma* sp. (5.6 leaves), which was significantly different from all other treatments.

Number of tillers

There was no interaction effects of water hyacinth compost treatment and *Tricoderma* sp. concentration on the number of tillers. The number of shallot tillers

Table 1. The number of leaves as affected by water hyacinth compost and *Trichoderma* sp. application at 6 WAP, 8 WAP, and 10 WAP

Trichoderma sp. Concentration (mL. L^{-1})	Number of leaves (strands)					
	6 WAP		8 WAP		10 WAP	
	Water hyacinth compost	Without water hyacinth compost	Water hyacinth compost	Without water hyacinth compost	Water hyacinth compost	Without water hyacinth compost
0 mL. L^{-1}	20.33 e	20.11 e	25.80 e	24.88 e	25.81 e	25.01 e
5 mL. L^{-1}	26.98 d	26.57 d	37.55 d	37.45 d	37.60 d	37.57 d
10 mL. L^{-1}	28.79 bcd	28.45 cd	46.28 c	46.15 c	46.60 c	46.57 c
15 mL. L^{-1}	30.47 bc	30.39 b	70.85 b	67.89 b	70.83 b	68.25 b
20 mL. L^{-1}	38.20 a	36.86 a	84.25 a	71.66 b	84.27 a	71.74 b
HSD 5%	2.26		5.66		5.66	

Remarks: Means accompanied by the same letters at the same observation time indicate no significant difference based on the Honest Significant Difference (HSD) test at a 5% level of significance, WAP = weeks after planting.

Table 2. The number of shallot leaves as affected by the application of water hyacinth compost fertilizer and *Trichoderma* sp. at 2 WAP and 4 WAP

Compost fertilizer treatment	Number of leaves (strands)	
	2 WAP	4 WAP
Water hyacinth compost	3.53	4.08
Without water hyacinth compost	3.34	3.91
HSD 5 %	ns	ns
Trichoderma sp. concentration		
0 mL.L^{-1}	2.64 c	2.74 d
5 mL.L^{-1}	2.90 bc	3.08 cd
10 mL. L^{-1}	3.11 bc	3.88 bc
15 mL.L^{-1}	4.36 ab	4.57 b
20 mL.L^{-1}	4.41 a	5.60 a
HSD 5%	1.36	0.88

Remarks: Means accompanied by the same letters at the same observation time indicate no significant difference based on the Honest Significant Difference (HSD) test at 5%. WAP = weeks after planting, ns = not significant.

Table 3. Number of shallot tillers as affected by water hyacinth compost application and *Tricoderma* sp. treatment at 2 WAP, 4 WAP, 6 WAP, 8 WAP, and 10 WAP

Compost fertilizer treatment	Number of tillers				
	2 WAP	4 WAP	6 WAP	8 WAP	10 WAP
Water hyacinth compost	5.30	7.80	9.01	9.10	9.11
Without water hyacinth compost	4.50	7.30	8.08	8.12	8.12
HSD 5%	ns	ns	ns	ns	ns
Trichderma sp. concentration					
0 mL.L^{-1}	4.8 a	7.10	7.40	8.40	8.45
5 mL.L^{-1}	5.1 b	7.23	8.10	8.70	8.70
10 mL. L^{-1}	5.3 bc	7.27	8.30	8.80	8.79
15 mL.L^{-1}	5.5 cd	7.30	8.40	9.60	9.65
20 mL.L^{-1}	6.6 d	7.40	9.90	10.80	10.82
HSD 5%	0.29	ns	ns	ns	ns

Remarks: Means accompanied by the same letters at the same observation time indicate no significant difference based on the Honest Significant Difference (HSD) test at 5%. WAP = weeks after planting, ns = not significant.

as affected by water hyacinth compost and *Tricoderma* sp. treatment is presented in Table 3.

Based on Table 3, the number of tillers was the highest in the water hyacinth compost application at 10 WAP (9.11), but was not significantly different from observations at 2 WAP, 4 WAP, 6 WAP, and 8 WAP, and also not significantly different from the control group without water hyacinth compost treatment. Meanwhile, at 2 WAP, the 20 mL.L^{-1} concentration treatment showed the highest value (6.61), which was significantly different from all other treatments. However, the number of tillers in the *Tricoderma* sp. concentration treatment at 4 WAP, 6 WAP, 8 WAP, and 10 WAP was not significantly different.

Bulb weight per plot

The interaction between treatment of water hyacinth compost and concentration of *Trichoderma* sp. was reflected on the bulb weight per plot of shallots of Bima variety (Figure 1).

As seen in Figure 1, the highest bulb weight per plant was 2455.33 g, which resulted from the application of water hyacinth compost and the concentration of *Trichoderma* sp. of 20 mL.L^{-1}. This result is significantly different from the other treatments but not significantly different from the treatment using a concentration of *Trichoderma* sp. of 15 mL.L^{-1}. Meanwhile, the lowest bulb weight per plot was found in the treatment without water hyacinth compost and without *Trichoderma*

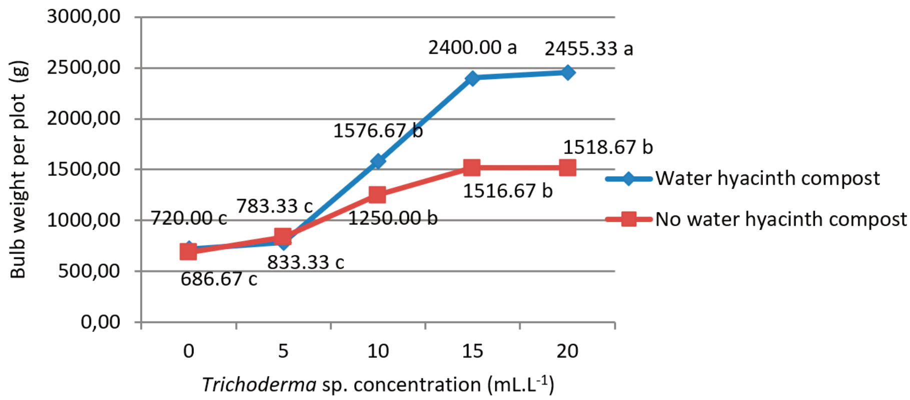

Figure 1. Bulb weight of Bima variety as affected by *Trichoderma* sp. concentration and water hyacinth treatments

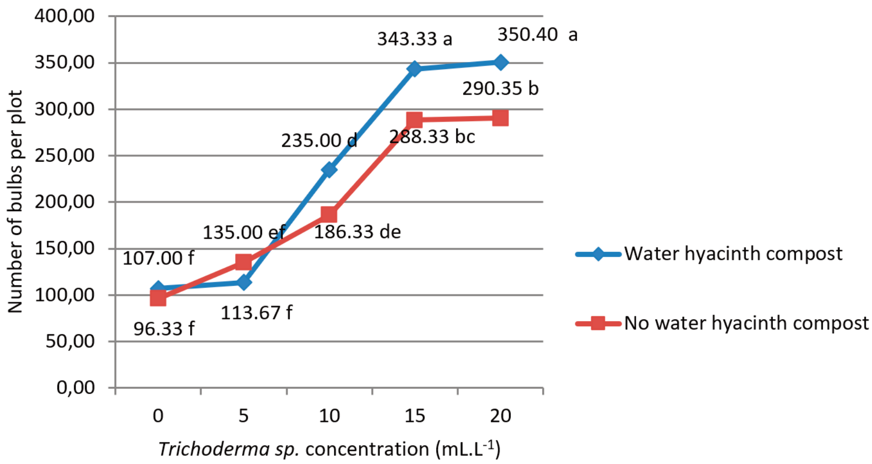

Figure 2. Number of shallot bulbs of Bima variety as affected by *Trichoderma* sp. concentration and water hyacinth treatments

sp. concentration, but it was not significantly different from the treatment without water hyacinth compost and Trichoderma sp. concentration of 5 mL.L^{-1}.

Number of bulb per plot

The interaction between water hyacinth compost and concentration of *Trichoderma* sp. can be seen from the number of bulbs of Bima variety per plot as presented in Figure 2.

According to Figure 2, the highest number of shallot bulbs per plot was 350.40 bulbs obtained from the treatment using water hyacinth compost and *Trichoderma* sp 20 mL.L^{-1}. This result was significantly different from other treatments but not significantly different from water hyacinth compost treatment and *Trichoderma* sp. at a concentration of 15 mL.L^{-1}. Meanwhile, the lowest number of bulbs per plot was found in the treatment without water hyacinth compost and without *Trichoderma* sp. concentration, but it was not significantly different from the treatment without water hyacinth compost and *Trichoderma* sp. concentration of 5 mL.L^{-1}.

Discussions

Plant productivity is highly dependent on internal factors (genetic and hormones) and external factors (plant growing environment). The growth of shallots of Bima variety had a different response to water hyacinth compost and concentrations of *Trichoderma* sp., which might be due to genetic factors, as well as water hyacinth fertilizer and the application of *Trichoderma* sp. concentration that stimulated higher yield components of Bima variety. Lende et al. (2020) stated that genetic factors were more dominant in affecting plant characteristics than environmental factors.

Single or combined microorganisms directly administered into the soil can increase plant yields. Lehar et al. (2016) agreed with the view as they stated that plants given a combined biological agents that include *Trichoderma*, *Pseudomonas fluorescens* and *Streptomyces* sp. are able to decompose lignin, cellulose, and chitin from organic matter into food and provide ready-to-absorb nutrients, which eventually increases crop yields.

Microorganisms applied directly into the soil is also believed effective in degrading organic matter in the soil as the organic matter is food for microorganisms to multiply. Biological agents added to organic fertilizers can act as decomposers of organic matter and reproduce themselves in the organic matter while providing nutrients to support plant growth (Lehar, 2012).

Leaves are the main photosynthetic organs in plants where light energy is converted into chemical energy and accumulates in the form of dry matter. Plant leaf organs are used as direct indicators of plant growth and yield. Lehar et al. (2021) reported that more leaves grew out of the treatment using water hyacinth compost with a concentration of *Trichoderma* sp. 20 ml L^{-1}, with 86.378 leaves. Along with the increase in the number of leaves, the leaf area will also increase accordingly. Wider leaves capture higher amount of sunlight and CO_2 fixation, resulting in more intensive photosynthesis, thereby affecting the assimilate yields to be continuously processed as the formation of plant bulbs (Yustiningsih, 2019). Similarly, Baihaqi (2013) stated that higher number of leaves was associated with better bulb production based on the fresh bulb weight per plant, which can indicate the yield of fresh bulb weight per plot and per hectare.

Lehar et al. (2017) mention that wider leaf as the main organ in photosynthesis absorbs more sunlight and CO_2 fixation, resulting in greater photosynthesis and assimilation, which affect the bulb formation. Sianturi et al. (2021) stated that the application of water hyacinth compost could influence the yield of shallots. The significant impact of water hyacinth compost application is observed in the number of bulbs, bulb diameter, fresh and dry weight of bulbs per clump, as well as the fresh and dry weight of bulbs per hectare. The compost dosage that has a positive impact on shallot yield is between 15 to 20 tons per hectare. The application of water hyacinth compost can enhance plant growth, such as a plant height of 30.70 cm, leaf count of 24.25 strands, fresh plant weight of 35.85 g, and dry plant weight of 7.17 g, (Komara, 2016). Optimal plant growth is likely to produce higher number of bulbs because plant production is determined in the vegetative growth phase (Lehar et al., 2021).

The vegetative growth of Bima variety indicated that the availability of nutrients in water hyacinth compost with the appropriate concentration of *Trichoderma* sp. allowed the number of tillers – which is one of plant growth indicators – to produce higher bulb yield per ton ha^{-1} (Figure 3).

The use of water hyacinth compost and *Trichoderma* sp. concentration of 20 mL.L^{-1} of water can have a positive impact on the growth of shallot plants. Water hyacinth compost provides additional nutrients to the soil, improves nutrient availability, and supports plant growth. Meanwhile, *Trichoderma* sp. acts as a biological agent that enhances plant health, reduces the risk

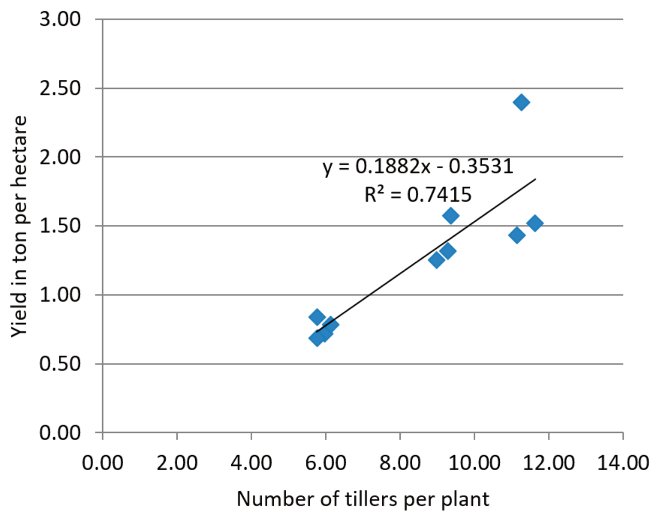

Figure 3. Number of shallot tillers in relation to bulb yield per ton.ha^{-1}

of disease, and stimulates root growth. With this combination, shallot plants tend to produce more and higher-quality bulbs, enhancing overall production. This treatment can improve resource utilization efficiency, minimize the risk of plant diseases, and optimize agricultural yield potential. As a result, especially for shallot commodities, productivity can become more sustainable. This corresponds to Figure 3, which indicates that the combination treatment using water hyacinth compost and *Trichoderma* sp. concentration optimizes the potential yield, where the bulb yield in tons per hectare is influenced by the number of tillers per plant with a coefficient of determination $R^2 = 0.7415$. It implies that the number of tillers per plant to a certain extent affects the bulb yield in tons per hectare by 74.15%.

The application of organic fertilizer stimulates higher vegetative and generative growth, ultimately leading to increased plant production. Solid organic fertilizer and liquid organic fertilizer, or a combination of both, show a significant response in shallot plants to parameters such as the number of leaves, harvest age, number of bulbs per clump, bulb diameter, fresh bulb weight per clump, dry bulb weight per clump, dry bulb weight per bulb, and bulb weight loss (Prasetyo and Ernita, 2022). The combination of organic fertilizer and biological control agents results in the highest fresh and dry weights, specifically 17,718.75 g or 17 kg fresh weight and 16,931.25 g or 16.9 kg dry weight. This combination of organic fertilizer and biological control agents significantly increases the highest fresh and dry weights compared to other treatment combinations (Agustini et al., 2017).

The administration of water hyacinth compost with the appropriate concentration of *Trichoderma* sp. allow the microorganisms to break decompose and provide balanced nutrients for plants. Nurman et al. (2017) state that balanced nutrients in the soil holds the key to the synthesis of carbohydrates and proteins, making bulbs easily multiply and grow size. Lehar et al. (2016) add that a plant will grow well in soil with sufficient nutrients that are easily absorbed by plant roots. It is also highlighted by Lehar et al. (2017) that vegetative organs are important, such as the leaf. which is the main organ in photosynthesis. The wider the leaf, the greater the amount of sunlight absorbed and CO_2 fixation, allowing better photosynthesis and assimilation, which eventually affects the number and weight of plant tubers/bulbs.

CONCLUSIONS

The treatment of water hyacinth compost fertilizer at 15 tons ha^{-1} with a concentration of *Trichoderma* sp. 20 mL.L^{-1} resulted in the highest number of shallot leaves and tillers, which was 84.27 strands and 10.82, respectively. The shallot bulb weight per plot was 2,455.33 g, and the number of bulbs per plot was 350.40 bulbs.

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REFERENCES

Agustini, Y., Purwatiningsih, and Sulistyanto, D. (2017). Kombinasi Pupuk Organik dan Agen Hayati Untuk Mengendalikan Hama Spodoptera exigua pada Tanaman Bawang Merah di Kecamatan Gending, Kabupaten Probolinggo. *Jurnal Ilmu Dasar*, 18(2), pp. 99–108.

Badan Pusat Statistik Jawa Tengah. (2020). *Dinas Pertanian dan Perkebunan Provinsi Jawa Tengah*. [online] Available at : https://jateng.bps.go.id/indicator/55/727/1/luas-panen-dan-produksi-bawang-merah.html [Accessed 5 Januari 2024].

Badan Pusat Statistik Nusa Tenggara Timur. (2020). *Vegetables Production (Quintal)*. [online] Available at: https://ntt.bps.go.id/indicator/55/595/1/produksi-tanaman-sayuran-menurut-kabupaten-kota.html [Accessed 5 Januari 2024].

Baihaqi, A., Nawawi M., and Abadi A.L. (2013). Teknik Aplikasi *Trichoderma* sp. Terhadap Pertumbuhan dan Hasil Tanaman Kentang (*Solanum tuberosum* L.). *J. Produksi Tanaman*, 1(3), pp. 30–39.

Dewi, M.K., and Sutrisna, I.K. (2016). Pengaruh Tingkat Produksi, Harga, dan Konsumsi Terhadap Impor Bawang Merah di Indonesia. *J Ekonomi Pembangunan Unud*, 5(1), pp 117–137.

Kusrinah, N., Alwiyah., Nur H. (2016). Pelatihan dan Pendampingan Pemanfaatan Eceng Gondok (*Eichornia crasspes* L.) Menjadi Pupuk Kompos Cair Untuk Mengurangi Pencemaran Air dan Peningkatkan Ekonomi Mayarakat Desa Karangkimpul Kelurahan Klaigawe Kecamatan

Gayamsari Kotamadya Semarang. *Jurnal UIN*, 16 (1), pp. 27–48.

Komara, W. (2016). *Pengaruh Pemberian Kompos Eceng Gondok (Eichornia crassipes) Terhadap Pertumbuhan Dan Hasil Bawang Merah (Allium ascalonicum L.)* B.A. Universitas Andalas.

Lehar, L., Arifin, Z., Heny, M.C.S. (2021). Pengujian Pupuk Kompos Eceng Gondok Dan Agen Hayati (*Trichoderma* sp) Terhadap Pertumbuhan Dan Penyakit Layu Fusarium Pada Budidaya Bawang Merah (*Allium ascalonicum* L.) Di Lahan Kering. *Jurnal Ilmiah Hijau Cendekia*, 6(2), pp. 86–92.

Lehar, L., Wardiyati, T., Maghfoer, M.D., and Suryanto, A. (2017). Influence of mulch and plant spacing on yield of *Solanum tuberosum* L .cv. Nadiya at medium altitude. *International Food Research Journal*, 24(3), pp. 1338–1344.

Lehar, L., Wardiyati, T., Maghfoer, M.D., Suryanto, A. (2016). Selection of potato varieties (*Solanum tuberosum* L.) in midlands and the effect of using biological agents. *Int. J. of Biosci*, 9(3), pp. 129–138.

Lehar L. 2012. Pengujian pupuk organik agen hayati (*Trichoderma* sp) terhadap pertumbuhan kentang (*Solanum tuberosum* L.). *J. Penelitian Pertanian Terapan*, 12(2), pp. 115–124.

Lende, A.N., Laurensius, L., and Heny, M.C.S. (2020). Application of organic fertilizer and Pseudomonas fluorescens on the growth and yield of shallot cultivar Sabu Raijua (*Allium ascalonicum* L.) in dry land. *GSC Advanced Research and Reviews*, 05(02), pp. 123–130.

Nurman, N., Elsa, Z., Isna, R.D. (2017). Pemanfaatan Zpt Air Kelapa Dan Poc Limbah Cair Tahu Untuk Pertumbuhan Dan Produksi Bawang Merah (*Allium ascalonicum* L.). *JOM Faperta UR*, 14(2), pp. 1–15.

Prasetyo A dan Ernita. (2022). Respon Pertumbuhan serta Produksi Tanaman Bawang Merah (*Allium ascalonicum* L.) terhadap Pupuk NPK Organik dan POC Urin Sapi. *Jurnal Agroteknologi Agribisnis dan Akuakultur*, 2(2), pp. 1–13.

Septania, V.P., Saidah, and Basri, Z. (2022). Pertumbuhan Dan Hasil Bawang merah (*Allium ascalonicum* L.) Pada Kombinasi *Trichoderma* assparellum Dan Pupuk Kandang. *Jurnal Agrotech*, 12(1), pp. 1–9.

Sianturi, R.I.E.S., Mukarlina, M., Zakiah, Z. (2021). Pertumbuhan Bawang Merah (*Allium ascalonicum* L. var. bauji) Dengan Pemberian Pupuk Organik Cair Campuran Limbah Kulit Nanas (*Ananas comosus* L.) Dan Eceng Gondok (*Eichornia crassipes* L.). *Jurnal Protobiont*, 10(3), pp. 60–64.

Sittadewi E.H. (2007). Pengolahan Bahan Organik Eceng Gondok Menjadi Media Tumbuh Untuk Mendukung Pertanian Organik. *Jurnal Teknik Lingkungan*, 8(3), pp. 229–234.

Sukmasari, M.D., Ita, Y., Adi, O.R.H. (2023). Pengaruh jarak tanam dan penggunaan pupuk hayati terhadap pertumbuhan dan hasil tanaman bawang merah (*Allium ascalonicum* L.) Varietas Bali Karet. *Agrivet: Jurnal Ilmu-Ilmu Pertanian Dan Peternakan*, 11(1), pp. 29–36.

Suprapta, D.N. (2012). Potential of microbial antagonists as biocontrol agents against plant fungal pathogens. *International Society for Southeast Asian Agricultural Sciences J*, 18(2), pp. 1–8.

Yustiningsih, M. (2019). Intensitas Cahaya dan Efisiensi Fotosintesis pada Tanaman Naungan dan Tanaman Terpapar Cahaya Langsung. *Bio-Edu Jurnal Pendidikan Biologi*, 4(2), pp. 43–48.