Utilization of Shrimp Shells Waste and Golden Snails to Increase the Yield of Shallots

Dian Indratmi[1,*], *Padhina* Pangestika[1], *Diva* Asih Raudya Tuzzahra[1], and *Mochammad* Wachid[2]

[1]Department of Agrotechnology, University of Muhammadiyah Malang, Jl. Tlogomas No. 246, Malang 65144, Indonesia
[2]Interdisciplinary Graduate Schools of Agriculture and Engineering, University of Miyazaki, 889-2155 Miyazaki, Gakuenkibanadainishi, 1-chome-1, Japan

Abstract. Shallots are high economic value commodities. The chemical fertilizers alone in onion cultivation can treat to agricultural sustainability. Environmentally friendly alternative fertilizers are urgently needed. One of them is Local Microorganism (LMO) which is developed from waste/natural materials, such as shrimp shells and golden snails which are available in nature. Shrimp shell contains nutrients N, P, K, C, Mg, and Fe. Golden snail is dangerous pest for rice plants, but it can be used as organic fertilizer. This study aims to determine effect of giving LMO of shrimp shells and golden snail for shallots growth and yield. The experiment used randomized block design with eight treatments, four replications, namely without LMO, 1.2 g plant^{-1} NPK fertilizer; 250 mL, 300 mL, and 350 mL shrimp shell LMO; LMO golden snail 250 mL, 300 mL, and 350 mL. The results showed that the provision of local microorganisms of shrimp shells and golden snails was able to increase shallot growth and yield, which was indicated by an increase in plant height, number of leaves, fresh weight, and dry weight of tubers per plant. The increase in tuber dry weight ranged from 130 % to 239 % (2.3 times to 3.4 times higher than control).

Keywords: *Allium ascalonicum* L., *Caridea* (Dana, 1852), local microorganism, *Pomacea canaliculate* (Lamarck, 1819), organic fertilizer, waste utilization.

1 Introduction

Shallots (*Allium ascalonicum* L.) are an important vegetable commodity whose tubers are used for spices or consumed directly. Data from Central Bureau of Statistics [1] shows that the productivity of national shallots has continued to increase from within a period of 4 yr, namely from 2013 to 2017, but in 2015 the productivity decreased from 1.234×10^6 t to 1.229×10^6 t. This proves that the productivity of national shallots is still not stable [2]. The potential for the development of shallots is still wide open because the need for shallots tends to increase from year to year in line with the growth of Indonesia's population. In

* Corresponding author: dian@umm.ac.id

addition to meeting the needs of domestic shallots but also abroad, so that productivity needs to be balanced [3].

One of the efforts to increase crop production is the use of appropriate fertilizers. Fertilizer is a very important means of production in food crop farming, horticulture, and plantations. Reduction of inorganic fertilizers needs to be done to reduce soil damage and dependence. The solution to this problem requires organic fertilizers that can restore soil fertility [4, 5]. Environmentally friendly and inexpensive fertilization is fertilization with organic fertilizer from Local Microorganisms (LMO). Organic fertilizers are fertilizers made from decayed organic materials [6–8].

Shrimp (Infraorder: *Caridea* Dana, 1852) exports are the highest foreign exchange earner from the fisheries sector. Increased shrimp production will also produce waste in the form of heads, skins, tails, and legs as much as 35 % to 50 % of the initial weight. The waste generated from the shrimp processing factory is shrimp freezing, shrimp canning, and shrimp crackers ranging from 30 % to 75 % of the weight of the shrimp. The increase in the amount of shrimp waste causes environmental pollution such as a pungent odor and poor environmental aesthetics [9]. Utilization of shrimp shell waste into local microorganisms is one of the efforts to reduce shrimp waste generated from shrimp processing plants. Most of the shrimp waste generated by the shrimp processing business comes from the head, shell, and tail. Shrimp shell contains protein (25 % to 40 %), chitin (15 % to 20 %), calcium carbonate (45 % to 50 %) [10]. One of the most dangerous pests for rice farmers is the golden snail (*Pomacea canaliculate* Lamarck, 1819). Newly planted rice can be consumed in a short time [11]. LMO golden snail is an organic fertilizer containing protein, carbohydrates, calories, and minerals such as Na, Ca, K, P, Mg, Zn and Fe, as well as vitamins that play a role in the process of hormone formation and function as coenzymes [12]. The use of LMO is believed to be able to maintain soil fertility, increase soil microbial populations, maintain environmental sustainability while being able to maintain and increase soil productivity [13–15].

Farmers can apply and utilize golden snails as organic fertilizer, so it can reduce production costs, ecosystem balance will be maintained, pests can be controlled and not become the main pest desease and can be beneficial for farmers. The results of the study show that seed preparation with liquid organic snail fertilizer and golden snail helped shorten the germination time, and treatment of the katokkon chili (*Capsicum chinense* Jacq.) variety affected plant height and residual fruit weight [16].

The aim of the study was to determine the effect of giving Local Microorganisms (LMO) of shells shrimp and golden snails, as well as the right dose on the growth and yield of shallot plants.

2 Methods

The study used a randomized block design with eight treatments and four replications. The treatments consisted of: without Local Microorganism (LMO) as control, 1.2 g plant^{-1} NPK fertilizer, local microorganism or LMO shrimp shell 250 mL, local microorganism shrimp shell 300 mL, local microorganism shrimp shell 350 mL, local microorganism of golden snail 250 mL, local microorganisms of golden snails 300 mL, local microorganism golden snail 350 mL. LMO was made using 4 kg of shrimp shells, 1 kg of brown sugar, 4 L of coconut water, 2 L of water and 4 L of rice washing water. Shrimp shells are grinded using a blender, mixed with all ingredients, and fermented in a container. The container is tightly closed and fermented until the temperature and pH are stable. LMO is harvested by filtering and transferring into a clean bottle. Before application, LMO is diluted with water in a ratio of 1:10.

Research activities include the manufacture of local microorganisms, chemical analysis of LMO nutrient content, preparation of planting media, planting, application of LMO, care and observation. The variables observed were nutrient content, plant height, number of leaves, fresh weight of tubers per plant, and dry weight of tubers per plant.

The data obtained were analyzed by analysis of variance and the F test. The difference between the treatment means was carried out using the Duncan Multiple Range Test (DMRT) with a level of 5 %. This research located in Diponegoro IV Street, No. 42 Dawuhan, Situbondo, East Java, Indonesia (coordinate 7°42'29"S and 114°00'28"E).

3 Result and discussion

3.1 Analysis of nutrient content

The results of the analysis of the main nutrient content (macro and micro elements) which include total N, P, K, Ca, Mg and S_2O_4 contained in the LMO solution of shrimp shells and golden snails are presented in Table 1.

Table 1. Analysis of nutrient content.

LMO types	N total (mg L^{-1})	P (mg L^{-1})	K (mg L^{-1})	Ca (mg L^{-1})	Mg (mg L^{-1})	S_20_4 (mg L^{-1})
		$HNO_3 + HClO_4$ (mg L^{-1})				
Shrimp shells	6 538.34	1 193.92	1 114.4	56.32	3.17	615
Golden snail	4 796.29	397.97	1 133.67	70.4	4.22	415

Note: LMO = Local Microorganisms.

The LMO of the shrimp shell contains higher N, P, and S elements than the LMO of the golden snail. On the other hand, the LMO of golden snail contains higher K, Ca, and Mg elements. The results of the analysis, LMO contains NPK nutrients lower than the quality standard of liquid organic fertilizer 5.57 % C-organic stipulated by the Regulation of the Minister of Agriculture No.70/Permentan/SR.140/10/2011. The NPK element in this case still needs optimization to increase the P content of the liquid organic fertilizer produced. This is caused by the activity of microorganisms. Microorganisms in addition to breaking down organic P into inorganic P also use P for their metabolic activities. The rich of NPK element content on shrimp shells-based fertilizer show it has big potential as organic fertilizer [17].

3.2 Plant height

The results of the analysis of variance showed that the LMO application had a significant effect on plant height. The mean height of shallot plants after the application of local microorganisms of shrimp shells and golden snails is presented in Table 2.

Table 2. Average plant height after application of LMO shrimp shell and LMO golden snail (cm).

Treatment	Plant height week (MSA)			
	2	4	6	8
Without LMO (control)	17.00 a	25.11 a	28.18 a	22.92 a
NPK fertilizer 1.2 g $plant^{-1}$	20.99 ab	26.52 ab	29.68 ab	28.31 b
LMO shrimp shell 250 mL	23.45 bc	31.68 c	32.98 c	32.71 b

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Table 2. Continue.

Treatment	Plant height week (MSA)			
	2	4	6	8
LMO shrimp shell 300 mL	25.62 bc	31.34 c	32.84 c	32.78 b
LMO shrimp shell 350 mL	24.56 bc	29.46 bc	33.01 c	30.12 b
LMO golden snail 250 mL	26.82 c	29.57 bc	32.35 c	31.57 b
LMO golden snail 300 mL	26.84 c	31.82 c	31.47 bc	31.60 b
LMO golden snail 350 mL	26.34 c	33.70 c	32.22 c	31.04 b

Note: Numbers accompanied by the same letter in the same column indicate that they are not significantly different according to DMRT at 5 % level. LMO = Local Microorganism.

The 250 mL shrimp shell LMO and 250 mL golden snail LMO treatment was a better treatment for plant height because the lowest dose was able to affect the onion plant height. This was due to the high N content in the LMO of shrimp shells and LMO of golden snails, where nitrogen was very important in the growth of plant height. In accordance with Maisura's *et al*. [18], opinion which states that with the N element, plants will be greener, and their growth will be faster which includes plant height, number of tillers, number of branches) and the protein content of crop yields increases. Giving gold snail liquid fertilizer has a significant effect on lettuce plant growth and giving gold snail fertilizer provides optimal growth and yields on growth parameters, namely the treatment of gold snail shells [19].

3.3 Number of leaves

The results of the analysis of variance showed that the LMO application treatment had a significant effect on the number of leaves of shallot plants. The average number of leaves after the application of LMO shrimp shells and golden snails is presented in Table 3.

Table 3. Average number of leaves after application of LMO shrimp shell and golden snail (pieces).

Treatment	Number of leaves week (MSA)			
	2	4	6	8
Without LMO (control)	7.46 a	10.17 a	12.12 a	11.17 a
NPK fertilizer 1.2 g plant^{-1}	9.17 a	12.59 ab	15.25 ab	14.88 ab
LMO shrimp shell 250 mL	14.59 c	20.92 d	25.58 c	20.21 bc
LMO shrimp shell 300 mL	11.50 ac	17.04 cd	20.42 bc	21.96 bc
LMO shrimp shell 350 mL	15.00 c	15.83 bc	21.50 c	24.83 c
LMO golden snail 250 mL	13.83 c	18.79 cd	20.17 bc	21.75 bc
LMO golden snail 300 mL	15.67 c	19.54 cd	21.25 bc	20.34 bc
LMO golden snail 350 mL	14.63 c	17.58 cd	18.75 bc	20.88 bc

Note: Numbers accompanied by the same letter in the same column indicate that they are not significantly different according to the DMRT at 5 % level. LMO = Local Microorganism.

The 250 mL shrimp shell LMO and 300 mL golden snail LMO treatment were better treatments than other treatments, where lower doses increased the number of leaves on shallot plants. It is suspected that the availability of macro and micronutrients contained in the LMO of shrimp shells and LMO of golden snails that synthesize and change the concentration of various phytohormones that trigger the growth of the number of leaves, such as nitrogen can accelerate growth and give good results in vegetative growth such as leaves, stems and roots that are strong has an important role in plants [17].

The element nitrogen which functions as a constituent of enzymes, protein synthesis enzyme LMO ecules and carbohydrate metabolism, phosphorus plays a role in chlorophyll and helps the translocation of phosphorus in plants. With the increase in the amount of chlorophyll, photosynthate which is active in transferring energy in plant cells and magnesium as a constituent formed will be even greater and encourage cell division and cell differentiation, where cell division is closely related to the addition of plant organs. The formation of the number of leaves is largely determined by the number and size of cells, also influenced by the amount of nutrients absorbed by the roots to be used as food [1].

3.4 Fresh weight and dry weight of bulbs per plant

The results of the analysis of variance showed that the LMO application had a significant effect on the fresh weight and dry weight of shallot bulbs. The average fresh and dry weight of tubers after the LMO application of shrimp shells and golden snails is presented in Table 4.

Table 4. Average fresh weight and dry weight of tubers per plant.

Treatment	Fresh weight of tubers (g)	Percentage increase in fresh weight (%)	Tuber dry weight (g)	Percentage increase in dry weight (%)
Without LMO (control)	11.67 a		9.21 a	
NPK Fertilizer 1.2 g plant^{-1}	15.13 ab	29.6	12.75 ab	38.4
LMO shrimp shell 250 mL	24.04 bcd	106.0	22.08 cd	139.7
LMO shrimp shell 300 mL	24.92 bcd	113.5	23.50 cd	155.2
LMO shrimp shell 350 mL	30.83 bcd	164.2	27.33 cd	196.7
LMO golden snail 250 mL	23.29 bc	99.6	21.21 bc	130.3
LMO golden snail 300 mL	33.63 d	188.2	31.21 d	238.9
LMO golden snail 350 mL	30.17 bcd	158.5	27.50 cd	198.6

Note: Numbers accompanied by the same letter in the same column indicate that they are not significantly different according to the DMRT test at 5 % level. LMO = Local Microorganism.

The fresh weight of tubers per plant was weighed after the tubers were harvested and cleaned of soil and the leaves had been cut. The dry weight of the bulbs per plant was obtained from the weighing of the shallot bulbs that had been harvested and air-dried for ± 5 d. The highest average fresh and dry weight of tubers was obtained from the 300 mL golden snail LMO treatment. The golden snail LMO contains microorganisms, fungi and bacteria that have the potential to remodel organic matter, stimulate growth and act as biological agents. In addition, some gold snail LMO bacteria are also able to bind free N_2 from the air and convert it into ammonia and help dissolve phosphorus elements so that nitrogen availability in the soil is maintained and phosphorus absorption increases [12].

The application of NPK fertilizer and local microorganisms, both shrimp shells and golden snails, was able to increase the yield of shallot bulbs. The increase in yield of fresh weight tubers ranged from 99.6 % to 188.2 % or (two to three) times higher than the control. The increase in dry weight tuber yields ranged from 130 % to 239 % or 2.3 to 3.4 times higher than the control. So, application of organic and inorganic fertilizers can increase soil productivity for plants so that it can increase the availability of nutrients quickly for plants. The increase in yield could not be separated from the increase in the growth of shallot plants which were better with the application of shrimp shells and gold snail shells, and both LMOs were proven to contain the main nutrients needed for plant growth and development.

In Indonesia, shallot productivity ranges from 3 t ha^{-1} to 12 t ha^{-1} with a national average of 9.47 t ha^{-1} [20]. The average productivity of shallots in East Java province reaches 7.5 t ha^{-1} [21]. From the results obtained, the average with LMO Golden Snail 300 mL L^{-1} treatment was 13.8 t ha^{-1}. Shallot productivity varies greatly depending on land conditions, climate, weather, varieties, and cultivation technology. The application of organic materials/local microorganisms with various materials often creates intangible benefits but has a real impact on increasing growth and yields [4, 5, 7, 8]. It is sustainable for both the soil and plant microenvironment [22–25, 14, 15].

4 Conclusion

Based on the results of the research that has been carried out, it can be concluded that giving LMO shrimp shells and golden snails can increase the growth and yield of shallot plants, as indicated by an increase in plant height, number of leaves, fresh weight, and dry weight of tubers per plant.

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