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## GSC Advanced Research and Reviews

e-ISSN: 2582-4597, CODEN (USA): GARRC2

Journal homepage: <https://www.gsonlinepress.com/journals/gscarr>

(RESEARCH ARTICLE)



## Application of organic fertilizer and *Pseudomonas fluorescens* on the growth and yield of shallot cultivar Sabu Raijua (*Allium ascalonicum* L.) in dry land

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Publication history: Received on 11 November 2020; revised on 20 November 2020; accepted on 23 November 2020

Article DOI: <https://doi.org/10.30574/gscarr.2020.5.2.0105>

### Abstract

The specific objectives of this study were 1 ) knowing certain types of organic fertilizers on the growth of shallots 2 ) knowing the concentrations of *Pseudomonas fluorescens* certain the growth of shallots, 3 ) knowing the types of organic fertilizers and the concentrations *Pseudomonas fluorescens* specificity increase the optimal yield of shallots. To achieve this goal, this research was conducted using factorial experiments with a split Plot Design with 10 treatments and 3 replications. So that there are 10 treatment combinations of a total number of 30 experimental plots. There were 2 factors that were tried, namely the first factor of Organic Fertilizer as the main plot, namely: cow manure 10 ton ha<sup>-1</sup> (K1), chicken manure 10 ton ha<sup>-1</sup> (K2). While the second factor as the subplot is the concentration of *Pseudomonas fluorescens*: Watering with water (as a control) 100 ml (P0), Watering with a concentration of *Pseudomonas fluorescens* 5 ml + normal water 95 ml (P1), Watering with a concentration of *Pseudomonas fluorescens* 10 + ordinary water 90 ml (P2), sprinkling with a concentration of *Pseudomonas fluorescens* 15 ml + 85 ml plain water (P3), Flushing with a concentration of *Pseudomonas fluorescens* 20 + ordinary water 80 ml (P4). The shallot cultivar of Sabu Raijua which was given organic fertilizer of 10 tonnes of chicken manure. Ha<sup>-1</sup> and a concentration of *Pseudomonas fluorescens* 20 + 80 ml of plain water gave the highest growth component at the age of 10 WAP, namely at the age of 10 WAP, namely plant height (37.667cm). Leaves (34, 800 trees), number of tillers (10, 533 trees). The results of shallot bulbs of Sabu Raijua cultivar from organic fertilizer treatment of 10 ton ha<sup>-1</sup> chicken manure with a concentration of *Pseudomonas fluorescens* 20 ml + 80 ml water resulted in components, namely tuber weight per plot (276.70 g), number of tubers per plot (291, 70 tubers).

**Keywords:** Organic Fertilizer; *Pseudomonas fluorescens*; Sabu Raijua Cultivar Shallot.

### 1. Background

Shallots (*Allium ascalonicum* L.) are one of the horticultural commodities with high economic value. Shallots are a spice vegetable horticultural commodity that is much needed, especially as a complement to cooking spices in order to increase the taste and enjoyment of food. In addition, onions function as medicine without side effects (as a traditional medicine that can cure fever, diabetes, and cough) and onions contain minerals, Ca, and Fe. In addition, there are also Vitamin B and C (Aryanta, 2019).

The consumption of shallots in East Nusa Tenggara (NTT) reaches 12,981 tons each year (Agromedia, 2011). The Indonesian Central Bureau of Statistics, (2014) informed that the consumption of shallots in NTT was 2,762 kg per capita per year. When compared to the production and consumption of shallots, NTT Province needs supplies of shallots from outside the region. Regions that supply the need for shallots in NTT are West Nusa Tenggara (NTB) and East Java.

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The average shallot production in East Nusa Tenggara (NTT) in 2012 reached 1,000 tons and increased in the following year to 3,100 tons with a land area of 844 ha with average productivity of 3.67 tons per ha. Lehar *et al.* (2018) states that in general the productivity of shallots in NTT is low, namely 3.7 - 3.8 tonnes/ha with a land area of 544 ha. While in NTB, the average productivity of shallots can reach 5.0 tonnes/ha, even in Bima regency it reaches 9.71 tonnes/ha (Wibowo, 2005). As population increases, the need for shallots continues to increase, therefore increasing production needs to be done.

The low productivity of shallots can be influenced by several factors such as seeds, cultivation techniques, and fertilization. Another obstacle that can cause low onion production levels in terms of quality and quantity is pathogenic infection (Shofiyani, 2014) so that a special way is needed to control pathogens in shallots. One of the factors that can cause shallots to develop root disease is a lack of beneficial microorganisms. In addition, plants will also experience obstacles in their growth (less fertile) due to the lack of nutrients available in the soil and the low ability of the roots to absorb the elements available to plants.

One of the factors that can increase the productivity of shallots is related to pathogens. The attack of pathogens can be reduced by the use of *Pseudomonas fluorescens* bacteria. *Pseudomonas fluorescens* are able to degrade a large number of organic compounds, interact with plants, and associate in the rhizosphere which is beneficial in agriculture and some are pathogenic. *Pseudomonas fluorescens* directly benefits plants, which can stimulate growth and improve plant health indirectly through inhibition of, or competition with pathogens and parasites (Loccoz and Defago, 2004 in Zainuddin, 2013).

The utilization of *Pseudomonas fluorescens* significantly reduced the incidence of bacterial wilt disease, respectively, 50%, 30%, 60%, and 60%. *B. subtilis* and *Pseudomonas fluorescens* can be used to control bacterial wilt in tomatoes caused by *Ralstonia solanacearum* in tomato plants (Istiqomah and Kusumawati, 2018). The research results of Istiqomah *et al.*, (2017) reported that administration *Pseudomonas fluorescens* is able to dissolve phosphate and produce IAA (Indole Acetic Acid). Both of these substances can increase plant growth and health so that it has an impact on increasing plant resistance to pathogen attack.

## 2. Material and methods

This study used a factorial experiment with a split Plot Design with 10 treatments and 3 replications. So that there are 10 treatment combinations with the total number so that there are 30 experimental plots. There are 2 factors that were tried, namely: The first factor is Organic Fertilizer as the main plot, namely K1: (10-ton hacow manure-1), K2 (10-ton chicken manure-1). The second factor as a subplot was the concentration of *Pseudomonas fluorescens*, namely P0 Flushing with 100 ml of plain water (as control), P1 concentration *Pseudomonas fluorescens* 5 ml with 95ml plain water, P2 concentration *Pseudomonas fluorescens* 10 with 90 ml plain water, P3 Watering with a concentration of 15 ml with 85 ml of plain water, P4 concentration *Pseudomonas fluorescens* 20 with 80 ml of plain water.

The research data obtained were analyzed using variance to determine the effect of the derived treatment in the study. If there is a significant difference in this study, it can be continued with the least significant difference (LSD) test at the 5% level.

## 3. Results and discussion

### 3.1. A. Results

#### 3.1.1. Components of Growth

Based on the results of the analysis of variance, it showed that there was an interaction between the application of organic fertilizers and the concentration of *Pseudomonas fluorescens* on the height of the shallot cultivar of Sabu Raijua at the age of 8 WAP and 10 WAP (Table 1).

**Table 1** Height of shallot cultivar of Sabu Raijua due to organic fertilizer treatment and concentration *Pseudomonas fluorescens* at 8 WAP and 10 WAP.

Treatment	Plant Height (cm)			
	8 WAP		10 WAP	
Concentration of <i>Pseudomonas fluorescens</i>	Fertilizer Manure Cow	Fertilizer Chicken Manure	Fertilizer Manure Cow	Fertilizer Chicken Manure
Water 100 ml kontrol	24.000 cd	26.000 c	19.500 e	25.000 cd
Pf 5 ml+air 95 ml	25.667 bc	28.833 d	22.443 de	26.610 cb
Pf 10 ml+air 90 ml	29.333 b	29.533 d	23.933 cd	30.500 b
Pf 15 ml+air 85 ml	35.667 a	35.766 b	23.000cde	36.633 a
Pf 20 ml+air 80 ml	36.333 a	38.333 a	37.000 a	37.667 a
LSD 5 %	4.56		4.09	

Information: accompanied by the same letter at the same time of observation showed no significant difference based on the LSD 5%, cm = centimeters, WAP = weeks after planting, Pf = *Pseudomonas fluorescens*, ml = milli liters.

**Table 2** Number of green onions in Sabu Raijua cultivar due to application of organic fertilizers and concentrations. *Pseudomonas fluorescens* age 8 WAP and 10 WAP.

Treatment	Number of leaves			
	8 WAP		10 WAP	
Concentration of <i>Pseudomonas fluorescens</i>	Fertilizer Manure Cow	Fertilizer Chicken Manure	Fertilizer Manure Cow	Fertilizer Chicken Manure
Air 100 ml kontrol	20.500 cb	18.113 c	21.567 bc	18.933 c
Pf 5 ml+air 95 ml	23.833 bc	21.110 bc	24.267 bc	21.700 bc
Pf 10 ml+air 90 ml	24.833 b	19.777 bc	25.533 b	20.333 bc
Pf 15 ml+air 85 ml	22.667 bc	32.000 a	23.267 bc	33.000 a
Pf 20 ml+air 80 ml	32.000 a	33.333 a	32.933 a	34.800 a
LSD 5 %	6.36		6.40	

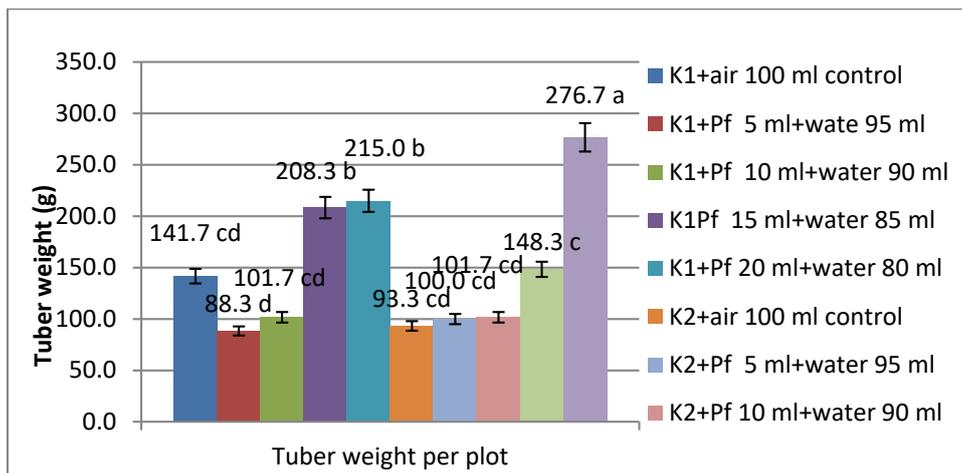
Information: accompanied by the same letter at the same time of observation showed no significant difference based on the LSD 5%, cm = centimeters, WAP = weeks after planting, Pf = *Pseudomonas fluorescens*, ml = milli liters.

**Table 3** Number of shallots saplings of Sabu Raijua cultivar due to organic fertilizer treatment and concentrations *Pseudomonas fluorescens* at age 6 WAP, 8 WAP and 10 WAP.

Treatment	Number of Tillers					
	6 WAP		8 WAP		10 WAP	
Concentration of <i>Pseudomonas fluorescens</i>	Fertilizer Manure Cow	Fertilizer Chicken Manure	Fertilizer Manure Cow	Fertilizer Chicken Manure	Fertilizer Manure Cow	Fertilizer Chicken Manure
Air 100 ml kontrol	3.943 ab	4.113 ab	4.833 b	4.166 bc	4.090 bcd	4.056 cd
Pf 5 ml+air 95 ml	4.223 ab	4.166 ab	4.500 bc	4.610 bc	4.500 bcd	4.610 bcd
Pf 10 ml+air 90 ml	4.000 ab	3.780 ab	4.280 bc	3.500 c	4.280 cd	4.500 d
Pf 15 ml+air 85 ml	4.556 a	4.000 ab	4.720 bc	9.166 a	5.833 b	9.933 a
Pf 20 ml+air 80 ml	3.723 ab	3.166 b	9.033 a	9.800 a	10.033 a	10.533 a
LSD 5 %	1.29		6.36		1.48	

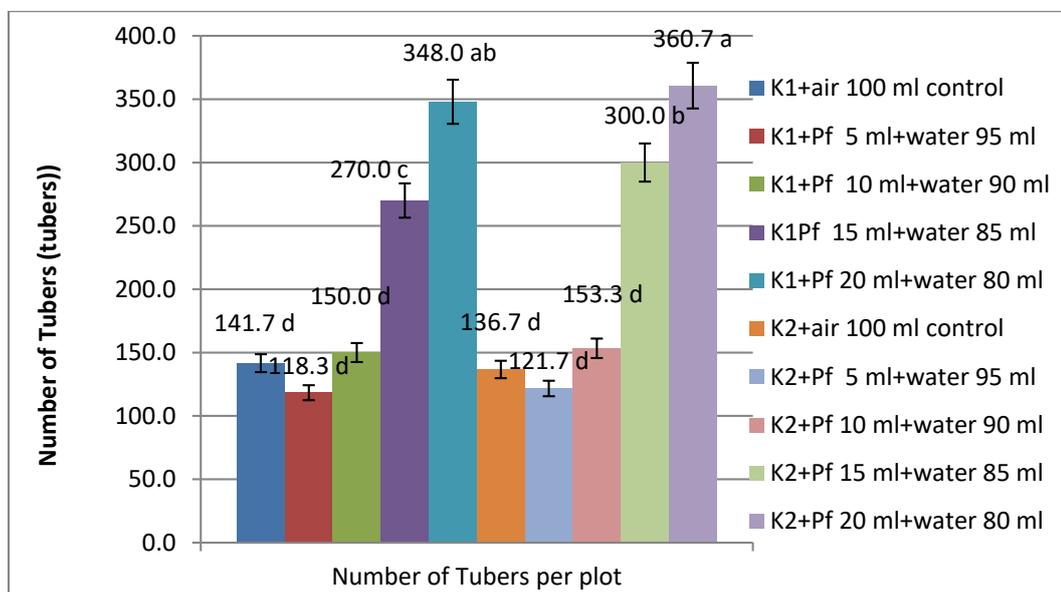
Information: accompanied by the same letter at the same time of observation showed no significant difference based on the LSD 5%, cm = centimeters, WAP = weeks after planting, Pf = *Pseudomonas fluorescens*, ml = milli liters.

### 3.2. Yield Component



Information: K1 = cow manure, K2 = chicken manure, Pf = *Pseudomonas fluorescens*, ml = milli liters, g = gram

**Figure 1** Tuber weight of the shallot cultivar of Sabu Raijua per plot due to organic fertilizer treatment and the concentration of *Pseudomonas fluorescens*.



Information: K1 = cow manure, K2 = chicken manure, Pf = *Pseudomonas fluorescens*, ml = milli liters.

**Figure 2** The number of shallot tubers of the Sabu Raijua cultivar per plot due to organic fertilizer treatment and the concentration of *Pseudomonas fluorescens*.

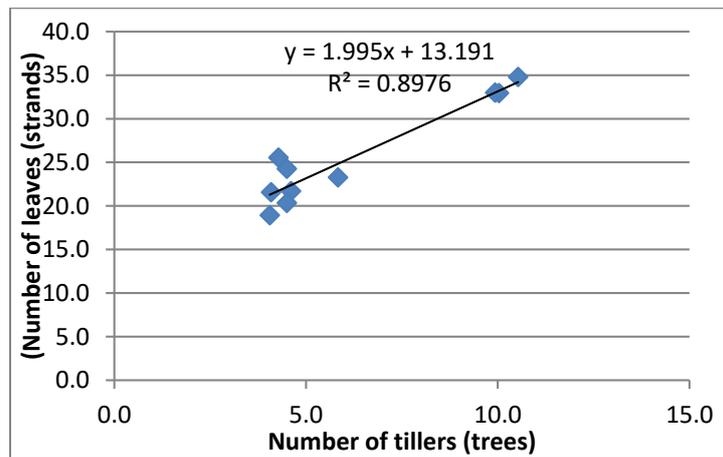
## 4. Discussion

### 4.1.1. Growth of Shallot Cultivar of Sabu Raijua

The process of plant growth is controlled by two factors, namely internal factors (genetics and hormones) and external factors (plant growth environment). The growth of the shallot cultivar of Sabu Raijua has different responses to organic fertilizers and the concentration of *Pseudomonas fluorescens*. It is suspected that genetic factors and organic fertilizers and the provision of concentration *Pseudomonas fluorescens* stimulated higher plant growth components compared to without *Pseudomonas fluorescens*. Lehar, (2012) states that genetic factors are more dominant in the characters displayed by plants because their genetic factors contribute more than environmental factors. Plants that have high

genetic diversity will greatly help a population adapt to changes that occur in the surrounding environment (Susanto and Baskorowati, 2018). Giving microorganisms directly into the soil is thought to be able to integrate organic matter in the soil as well as these organic materials into food for microorganisms to reproduce themselves. Lehar *et al.* (2016) stated that plants that are given a combination of biological agents in which there are *Trichoderma*, *Pseudomonas fluorescens*, and *Streptomyces sp*, are able to decompose lignin, cellulose, and kithin from organic matter into their food and provide nutrients that are ready to be absorbed by plants. Organic material fed with microorganisms is able to reproduce itself according to the conditions of the organic material. This is in line with the opinion of Lehar, (2012) which states that the biological agents given to organic fertilizers will be able to act as decomposers of organic matter and multiply themselves in these organic materials and provide nutrients to support plant growth.

The greater the vegetative growth of the shallot cultivar of Sabu Raijua shows that the availability of nutrients in organic fertilizers with concentration *Pseudomonas fluorescens* the appropriate so that one of the growth components, namely the number of leaf clumps increases with the increasing number of tillers (Figure 3).



**Figure 3** The relationship between the number of tillers and the number of leaves per clump.

Figure 3 shows the number of leaves per clump tendency is influenced by the number of tillers with determination coefficient  $R^2 = 0.8976$ . This indicated that the number of leaves at a certain limit affected the number of tillers per clump by 89%. The application of organic fertilizer and the right concentration of *Pseudomonas fluorescens* can increase the highest growth component of cabbage on plant height (32.55 cm), number of plant leaves (22.02), leaf length with petiole (31.48 cm), leaf width (22.59 cm), root length (20.79 cm), stem length (4.043 cm) at harvest (Rezaul *et al.*, 2013). The high number of leaves with suitable spacing allows optimal absorption of sunlight and results in photosynthesis to produce larger photosynthate. Lehar *et al.*, 2017 said that, a greater production of photosynthate allows the formation of all plant organs such as roots, stems, leaves and tubers in greater numbers.

Provision of biological agents functions as a decomposer of organic matter and biological agents capable of stimulating the growth of plant root systems and inhibiting harmful bacterial fungi. Lehar (2016) and Rosyida *et al.*, (2013) stated that the provision of organic matter which was decomposed by the biological agent *Tricoderma viride* and combined with *Pseudomonas fluorescens* and *Streptomyces sp*, was also able to increase plant height, leaf number and number of tillers.

Ningrum *et al* (2017) and Soesanto *et al.*, (2014) suggest that giving biological agents to plants can replace chemical fertilizers, pesticides and hormones that can be used in plant growth so as to increase plant height, root length and crop yield. Various studies have shown that *P. fluorescens* isolated from the rhizosphere can increase the growth of rice plants (Anhar *et al.*, 2011), tomatoes Ardebili *et al.*, 2011), corn (Rahni 2012), and soybeans (Habazar *et al.* 2014).

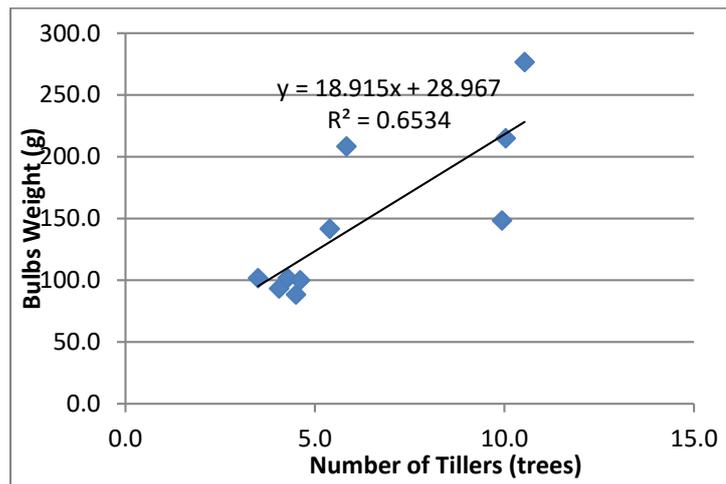
#### 4.2. Shallot Plant Yields of Sabu Raijua Cultivar

The plant organ that is used as a direct indicator of the growth and yield of the shallot cultivar of Sabu Raijua is the leaves. Leaves are the main photosynthetic organ in plants, where the process of converting light energy into chemical energy and accumulates it in the form of dry matter occurs. The number of leaves that was higher was the treatment of chicken manure with a concentration of *Pseudomonas fluorescens* 20 ml + 80 ml water, namely 34,800 strands (Table 3). As the number of leaves increases, the leaf area will increase accordingly. The wider the leaves, sunlight capture and CO<sub>2</sub> fixation the higher that large photosynthesis will also affect large assimilate yields, and are continuously processed

in the formation of plant tubers (Lakit, 2008 in Arifin *et al.*, 2014). This is also in accordance with the research of Baihaqi (2013) which states that the more the number of leaves, it shows that tuber production will be high, namely by looking at the fresh weight of tubers per plant, it can be used as an indicator of the yield of fresh tuber weight per plot and per hectare.

Lehar *et al.*, (2017) say that the function of leaves as the main organ in photosynthesis where the wider the leaves, the higher the sun's capture and fixation of CO<sub>2</sub> so that large photosynthesis will also affect the large assimilate yield as well, and are continuously processed in the formation of plant tubers. This is consistent with the results of research by Khalafalla (2001) which states that the number of tubers has a significant effect on potato yields. The better the plant growth, there is a tendency to produce a larger number of tubers because plant production is very much determined in the vegetative growth phase.

The vegetative growth of the shallot cultivar of Sabu Rajiua shows that the availability of nutrients in organic fertilizers with concentration *Pseudomonas fluorescens* the appropriate so that one of the growth components, namely the number of tillers, can increase the tuber weight of the plots (Figure 4).



**Figure 4** The relationship between number of tillers and tuber weight per plot.

Figure 4 shows the tendency of tuber weight per plot is affected by the number of tillers with determination coefficient  $R^2 = 0.6534$ . This shows that the number of tillers at a certain limit affects the tuber weight by 65.34%.

The application of organic fertilizers will increase higher vegetative growth which results in increased crop production (Rai, (2010; Jigme *et al.*, 2015) Furthermore, Hayati *et al.*, (2011) states that the highest average growth component is found in the combination Fertilization treatment of 50% organic fertilizer + 50% inorganic fertilizers and growth stimulating substances contained in biological agents have higher growth component values and higher yields, while the combination of 100% organic fertilizer fertilization treatment yields the lowest yield of maize.

Organic fertilizers and biological agents as decomposers will be able to provide balanced nutrients for plants.. Nurman *et al.*, (2017) stated that the balance of nutrients, especially in the soil, plays a very important role in the synthesis of carbohydrates and proteins so it is very helpful in enlarging tubers. Lehar *et al.*, (2016) added that a plant will grow well, if nutrients are needed Enough is available in a form that is easily absorbed by plant roots. This is reinforced by Lehar *et al.*, (2017) which states that the function of vegetative organs such as plant leaves is the main organ in photosynthesis where the wider the leaves, the higher the sun's capture and fixation of CO<sub>2</sub>, so that large photosynthesis will affect large assimilate yields. also, and will affect the number and weight of plant tubers.

Generally, the provision of biological agents has a resistance system response in plants because it can produce several phenols that can be used to produce pathogens so as to provide plant immunity against a disease so that it can increase plant yield (Rosyida *et al.*, (2013). *Pseudomonas fluorescens* is one of the antagonistic microorganisms for biological control and helps increase crop yields (Nasrun and Nurmansyah, 2016; Istiqomah *et al.*, (2017)).

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## 5. Conclusion

The results of the research concluded that: 1) The shallot cultivar of Sabu Raijua which was given organic fertilizer of chicken manure 10 ton ha<sup>-1</sup> with a concentration of *Pseudomonas fluorescens* 20 ml + 80 ml water produced the highest growth component at the age of 10 MST, namely plant height (37.667cm) , number of leaves (34,800 trees), number of tillers (10,533 trees). 2) Organic fertilizers that can increase the growth and yield of shallot cultivars of Sabu Raijua, namely Ayami manure 10 ton ha<sup>-1</sup>. 3) The results of the shallot bulbs of Sabu Raijua cultivar from the treatment of organic chicken manure 10 ton ha<sup>-1</sup> with a concentration of *Pseudomonas fluorescens* 20 ml + 80 ml of water produced components, namely tuber weight per plot (276.70 g), the number of tubers per plot ( 291.70 tubers).

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## Compliance with ethical standards

### Acknowledgments

Thanks to fellow researchers whose name is listed in this article. Result this study is dedicated to the development science

### Disclosure of conflict of interest

The author states that this research has been carried out and there is no conflict of interest.

### Author contribution

ANL Design and mean of research and data collection, LL conducts research, data collection, data analysis as well script writing, review manuscripts, and submit the manuscript. HMCS conducts research, collects data, analyzes data, collects references.

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