The Use of Organic Fertilizer as an Alternative to the Scarcity of Chemical Fertilizers in the Cultivation of Shallots (*Allium Ascalonicum* L)

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Abstract

Organic waste, such as household, market, paper, weeds that grow on agricultural commodities, and livestock manure, can be composted aimed at recycling. Composting of organic waste uses fermentation technology in waste processing that facilitates waste reduction to landfills and the study aimed recycling of plant nutrients and organic materials from biological waste to cultivated soil. The composting process runs when organic waste is mixed with microorganisms as elements that decompose organic waste which can increase the growth and production of shallots. The purpose of the study was to find solutions and alternatives to the scarcity of chemical fertilizers, especially subsidized fertilizers, by utilizing organic waste in increasing shallot production. The method used in this study was a factorial randomized block design with 2 organic fertilizer treatments consisting of solid organic fertilizer (SOF) and liquid organic fertilizer (LOF) and the analysis method of conversion of production/hectare of shallot bulbs. The results showed that the SOF treatment at a level of 3.5 kg/plot (P3) and the LOF treatment at a level of 750 ml/liter of water/plot (C3) were the best in terms of plant height, number of tillers, bulb diameter, dry bulb production and production conversion/hectare. The use of organic fertilizer is very important for farmers in Indonesia with many benefits, such as improving soil structure so that the soil becomes fertile, rich in nutrients, microorganisms, economical and not dependent on inorganic fertilizers or subsidized fertilizers, easy to make and use, the most important thing is the ability of farmers to independently use organic fertilizers to increase shallot production.

***Keywords**:* Fermentation, Organic Waste, Production, Shallot

Introduction

The scarcity of chemical fertilizers, especially subsidized fertilizers in recent years has triggered an increase in fertilizer prices and in some areas there has been a shortage of fertilizers. This happened because importers of chemical fertilizer raw materials experienced a civil war between Russia and Ukraine [1]. This causes shallot farmers not to cultivate them, resulting in a shortage of production and causing the price of shallots to soar, and to address the shortage of shallots on the market, the government imports shallots from several producing countries [2] The solution to the scarcity of chemical fertilizers can be addressed by using organic fertilizers sourced from organic waste, considering that waste is a major problem in Indonesia with waste production reaching 65,200,000 tons per year with a population of 261,115,456 people in 2016, it is projected that population growth will increase as waste is produced and of course waste production will increase. The Indonesian government is reducing waste through a policy in the Presidential Regulation (Pepres) of the Republic of Indonesia Number 97 of 2017 concerning the policy of carrying out prevention, reduction, recycling with reuse which can be achieved by targeting a reduction in household waste and the like by 30 percent and handling waste by 70 percent [3]. Waste management is not the responsibility of the goverment, it can be done together with the community because it is undeniable that living things depend on nature. Waste is grouped into two parts, organic and non-organic waste. In the study, it focuses more on organic waste that mostly comes from the human environment where people live, such as daily human life in cooking and consuming, such as household waste, farmers harvesting agricultural and livestock products also create organic waste, there are many organic wastes that have not been utilized even though nature has provided all the elements to make organic waste can be turned into organic fertilizer. Organic fertilizers are physically of two types, namely solid (compost) and liquid [4]. Organic waste is defined as materials discarded in the household and agricultural sectors such as rice straw, corn straw, soybean straw, peanut straw, livestock manure, coconut fiber and shells, rice bran, and the like. In general, agricultural waste is divided into pre-, harvest-, and post-harvest waste. Furthermore, post-harvest waste can be classified into groups of waste before processing and waste after processing or agricultural industrial waste [5].

Composting is a natural process originating from microbial succession, marking the degradation and stabilization of organic matter present in waste. The use of microbial additives during composting is considered very efficient, most likely to increase the production of different enzymes resulting in a better waste degradation rate [6]. While LOF is a simple fermentation process using organic waste as a carbon substrate. Liquid organic fertilizer consists of essential plant nutrients and beneficial microorganisms, which recycle organic matter [7]. This study used several organic wastes fermented anaerobically to obtain maximum organic fertilizer results using goat manure, egg shells, tofu dregs, rice washing water, empty oil palm bunches. This waste was chosen because of its abundant availability and has a high content of macro and micro nutrients [8]., [9]., [10]., [11]., [12].

Shallots are one of the leading vegetable groups in Indonesia, the demand for shallots used in everyday life is very large. This product has an impact on the economy because of high market demand, price fluctuations can affect inflation so that it becomes part of Indonesia's economic strategy [13]. The development of shallot cultivation through agro-industry can be achieved through increasing production and increasing farmers' income. In Indonesia, the demand for shallots for food and seeds increases fivefold each year. This situation is similar to the fact that the population of Indonesia is increasing from year to year [14].

The common problem that occurs is that public demand for shallots is very high and does not match production performance. Therefore, the government's policy is to import shallots. Because the shallot harvest is seasonal, if this situation continues, supply and demand may be unstable throughout the year. Shallot production has increased over the past four years along with the increasing area of shallot cultivation while shallot consumption continues to increase throughout the year. However, this creates an imbalance between production and consumption, as seen in Table 1.

Table 1. Harvested Area, Production, and Demand for Shallots in North Sumatra 2017-2021.

Year	Harvest Area (ha)	Production (tons)	Consumption (tons)
2017	2.090	16.103	37.996
2018	2.194	16.347	41.803
2019	2.356	18.717	48.794
2020	3.148	28.830	44.120

2021	3.012	11.938	44.792

Source: [15]

Based on the explanation above, it is very important to carry out this research considering that the purpose of this research is to find solutions and alternatives to the scarcity of fertilizer, especially subsidized fertilizer, by utilizing organic waste to increase red onion production.

Literature Review

Organic waste as a source of natural materials and soil nutrients, agricultural waste including plantations and livestock such as straw, plant or shrub residues, pet waste and the like are sources of organic materials and plant nutrients. The waste can be placed directly on agricultural land or buried, for more effective results, it is better to do the processing process first, the natural decomposition of the waste takes 3-4 months or more, so that conservation efforts by using organic materials on agricultural lands are hampered. It will be even more complicated if faced with a pressing planting season, so it is often considered less economical and inefficient. One method of accelerating the decomposition of agricultural waste so that it can immediately function in improving soil properties and nutrient availability is by making compost [5]. Basically, the mechanism for making solid and liquid organic fertilizers works the same way, namely by fermentation and the finished products are different, namely solid and liquid. Now, thinking and creativity go hand in hand so that the idea arose to make solid organic fertilizers (SOF) and liquid organic fertilizers (LOF) carried out the manufacturing process simultaneously, considering that organic fertilizers are now a necessity for our society, especially farmers who understand the meaning of health for the soil as a growing medium and for that it is necessary to design organic waste processing tools whose final results produce SOF and LOF. SOF and LOF technology as a tool that helps decompose organic waste into SOF and LOF in a shorter time of around 21 days, the results of POP when applied to the soil will be able to improve the soil structure so that the chemical properties of the soil become nutrients in the soil change as well as the biological properties of the soil in this case microorganisms act as decomposing agents so that the physical properties of the soil become crumbs so that aeration and drainage run as expected [16].

Solid natural fertilizer is one of the bokashi fertilizers that is composed of waste from living things, such as the remains of plant, animal, and human decay that have been combined. With the combination of these waste materials, it is expected to be able to meet the nutrient needs of plants. One type of waste is cow dung which is now widely used to make bokashi fertilizer. Bokashi is one way to use soil microbes in making organic fertilizer by using the help of EM4 (Effective Microorganisms 4) as an activator that can accelerate the process of making organic fertilizer. The nutrient content in cow dung is C-Organic 18.76%, N 1.30%, P 0.52%, K 0.95%, Ca 1.06%, Mg 0.86%, Na 0.17%, Zn, 122ppm, Cu 20ppm, and Mn 334 ppm [17]. Empty oil palm bunches are waste produced from fresh fruit bunches containing nutrients N, P, K and Mg. Empty Oil Palm Bunch Compost (OPBC) is a palm oil mill waste that is very large in quantity. The nutritional content of OPBC is C 35%, N 2.34%, C/N 15, P 0.31%, K 5.53%, Ca 1.46%, Mg 0.96% and water 52%. OPBC compost can be applied to various plants as organic fertilizer, either alone or in combination with other plants. [18]. According to [19], the main ingredient of a very good natural liquid fertilizer from wet organic waste that has a high water content such as fruit waste. This material is rich in nutrients needed by plants. The nutrient content in fruit waste is N 3.35%, P 0.36%, K 0.46%, Ca 0.12%, and Mg 0.02%. The greater the cellulose content of organic material, the longer the bacterial decomposition process will be.

Shallots (Allium ascalonicum L.) are one of the superior horticultural commodities that are currently widely available in the market and have very good prospects for development, both as a source of income for farmers to meet the needs of local and national consumers. Shallots from the Lilyceae family originating from Central Asia are one of the plant commodities that are often used as a flavoring agent for cooking. In addition, shallots also contain nutrients and compounds that are classified as non-nutritional substances and enzymes that are useful for therapy, as well as improving and maintaining human health. [20]. Shallot plants are plants that have the most popular form of the Alliaceae family, shallot plants come from the genus Allium and contain many colored varieties. Shallots are the second oldest vegetable after tomatoes, both are widely used in Indonesia and throughout the world as additional ingredients for cooking [21]. Shallots contain protein, fat, carbohydrates, vitamins, minerals and compounds that function as antimutagens and anticarcinogens. Every 100 grams of shallot bulbs contain 80-85 g of water, 1.5 g of protein, 0.3 g of fat and carbohydrates. 9.3 g. The Sanren F1 shallots variety produces hybrid plants with a plant height of 54.03 - 56.50 cm, round and flat leaves, dark green leaf color, white flower color, flowering age 31 - 34 HST, harvest age 62 - 64 HST, round bulb shape with a diameter of 3.4 - 3.6 cm, flat, slightly round, black seeds with a weight per bulb reaching 17.05 - 19.40 g, each bunch contains 2 - 4 bulbs with a number of offspring of 2 - 4. The advantages of this variety are high production and medium tuber size and it can also adapt well to lowlands [22]. Many innovations become great not because of the novelty of the findings, but because of the continuous effort to improve them. Superior varieties of national shallots that are productive and adaptive to the climate need to be promoted in a technology-based agribusiness vehicle [23].

Research Methodology

The research was conducted in Minta Kasih village, Salapian sub-district, Langkat district, North Sumatra province with an altitude of ± 89 meters above sea level, the distance of the research location is 47 km from the UNPAB campus, involving 2 lecturers and 1 active student from the agrotechnology study program. The research period starts from November 2023 to May 2024.

The data collection technique for this research was carried out in three ways, namely by the observation method or direct observation of the object being studied in this case the observed parameters. Furthermore, the document study method, namely the collection of data from parameter observations which are then processed according to the data analysis method and then the last one with the literature study method, where the results of the data processing are supported by theories obtained from literature or library studies so that this research can be accounted for.

This study used an area of 1 meter x 1 meter (demplot) or called a square land using a planting distance of 20 cm x 20 cm so that a population of 16 plants was obtained in 1 demo plot, while the sampling technique was carried out randomly with a simple random sampling model or the sampling process was carried out by giving equal opportunities to each population of shallot plants in each demo plot there were 16 plant populations, so that the number of samples taken was 10 plants. The research method used a factorial randomized block design (RBD), consisting of 2 treatments with 16 treatment combinations and 2 replications with a total number of plots of 32. The following 2 treatment factors consist of:

a. The SOF treatment factor with the symbol "P" consists of 4 levels, namely;
   P0 = 0 kg/plot
   P1 = 1,5 kg/plot
   P2 = 2,5 kg/plot
   P3 = 3,5 kg/plot
b. The LOF treatment factor with the symbol "C" consists of 4 levels, namely;
   C0 = 0 ml/liter water/plot
   C1 = 250 ml/liter water/plot
   C2 = 500 ml/liter water/plot
   C3 = 750 ml/liter water/plot

The analysis of observational data used is analysis of variance based on a linear model, namely the analysis model used in the analysis of this research data, namely:

$Ýijk = \mu + pi + \alpha j + \beta k + (\alpha\beta)jk + \Sigma ijk$

Information:

Ýijk = Observation results in the i-th block, provision of the j-th SOF and provision of the k-th level of LOF.

μ = The effect of the mean value.

pi = Effect of block i.

αj = Effect of giving SOF at the j-th treatment level.

βk = The effect of POC administration at the k-th level.

(αβ)jk = Interaction between factors and SOF provision at the j-th level and LOF provision at the k-th level.

Σij = The effect of error on the i-th block, the j-th SOF assignment factor and the k-th LOF assignment factor [24].

The analysis method for converting the production/hectare of shallot bulbs used is the following formula:

$$\frac{\mathbf{Q\ (m^2)\ x\ H(g)}}{\mathbf{L(m^2)}}$$

Q = Land Area/Ha (m^2)

H = Bulbs/Plot (g)

L = Area/plot (m^2) [25].

Results

1. Plant Height (cm)

The average data of observation results from the measurement of plant height parameters (cm) of shallots due to solid organic fertilizer (SOF) treatment and liquid organic fertilizer (LOF) treatment at plant ages of 4, 5 and 6 weeks after planting, then after analysis of variance showed that SOF treatment had a very significant effect at ages of 4, 5 and 6 weeks after planting, while LOF treatment had a very significant effect at the age of shallots at 4, 5 and 6 weeks after planting.

Table 1. Average plant height (cm) with SOF (P) and LOF (C) treatments 4, 5 to 6 weeks after planting (WAP).

Treatment	Age Plant Height (cm)		
	4 WAP	5 WAP	6 WAP
Solid Organic Fertilizer (P)			
P0 (0 kg/plot)	36,96bB	42,72cC	50,38bB
P1 (1.5 kg/plot)	38,34bB	42,98cC	50,81bB
P2 (2.5 kg/plot)	38,61bB	43,91bB	51,88bB
P3 (3.5 kg/plot)	41,95aA	47,92aA	57,33aA
Liquid Organic Ferlilizer (C)			
C0 (0 ml/liter water/plot)	37,49aA	42,61bB	50,18bB
C1 (250 ml/liter water/plot)	38,04bB	43,49bB	50,77bB
C2 (500 ml/liter water/plot)	39,97 abAB	44,61 abAB	53,57abA
C3 (750 ml/liter water/plot)	41,44aA	46,79aA	55,87aA

Description: In the Multiple Range Test (BMRT), numbers in the same column followed by letters are significantly different at the 5% level (lowercase letters) and significantly different at the 1% level (capital letters).

The data in table 1 above shows that plant height (cm) due to SOF administration at the age of 4, 5 and 6 weeks after planting has a very significant effect. The highest average of SOF administration was found in P3 which was very significantly different from P2, P1 and P0. Furthermore, the LOF treatment had a very significant effect at the age of 4, 5 and 6 weeks after planting. The highest average was found in the treatment of 750 ml/liter of water/plot (C3) which was 55.87 cm which was significantly different from 500 ml/liter of water (C2) which was 53.57 cm, but very significantly different from 250 ml/liter of water/plot (C1) which was 50.77 cm and 0 ml/liter of water/plot (C0) which was 50.18 cm. This proves that various organic waste formulated into two types of organic fertilizers can increase the growth of shallot plants. This is in line with the statement [26] that organic waste from fruit contains enzymes that can help break down nutrients in the soil so that it can increase the availability of nutrients such as Nitrogen, Phosphorus, Potassium, Calcium, Iron, Sodium, Magnesium and Vitamins, a similar thing was conveyed by [27].

2. Number of tubers

Data on the average measurement of the number of tillers in shallot plants (*Allium ascalonicum* L) aged 5, 6 and 7 weeks after planting with SOF and LOF treatments that have been tested for mean differences using the multiple distance test (Duncan) and analysis of variance on the parameter of the number of bulb tillers in shallot plants aged 5, 6 and 7 weeks after planting and the average results using the Duncan distance test can be seen in table 2.

Table 2. Average Number of Offshoots (tubers) Due to SOF and LOF Application at 5, 6 and 7 Weeks After Planting (WAP).

Treatment	Number of tuber offspring		
	5 WAP	6 WAP	7 WAP
Solid Organic Fertilizer (P)			
P0 (0 kg/plot)	1,45bB	1,86bB	2,88cC
P1 (1.5 kg/plot)	1,54bB	2,00bB	2,99cC
P2 (2.5 kg/plot)	1,76bB	2,24aA	3,20bB
P3 (3.5 kg/plot)	2,20aA	2,89aA	3,85aA
Liquid Organic Ferlilizer (C)			
C0 (0 ml/liter water/plot)	1,53bB	1,90bB	2,86cC
C1 (250 ml/liter water/plot)	1,61bB	2,21bB	3,03bB
C2 (500 ml/liter water/plot)	1,65bB	2,23 bAB	3,35bB
C3 (750 ml/liter water/plot)	2,16aA	2,65aA	3,68aA

Description: In the Multiple Range Test (BMRT), numbers in the same column followed by letters are significantly different at the 5% level (lowercase letters) and significantly different at the 1% level (capital letters).

Table 2 above shows that the provision of SOF has a very significant effect on the number of tubers at the age of 5, 6 and 7 weeks after planting. The highest average was found in the 3.5

kg/plot (P3) treatment, namely 3.85 shoots and the lowest was 0 kg/plot (P0), namely 2.88 shoots. The results of the regression analysis of SOF administration on the number of tubers showed a linear relationship. LOF administration had a very significant effect on the number of tubers at the age of 5, 6 and 7 weeks after planting. The highest average was found in the 750 ml/liter water/plot (C3) treatment, namely 3.68 shoots and the lowest was 0 ml/liter water/plot (C0), namely 2.86 shoots. The results of the regression analysis of LOF administration on the number of tubers showed a linear relationship. This is in accordance with the opinion [28] which states that the provision of organic materials can increase nutrient concentration, storage, porosity and water supply in the soil as well as soil aeration and temperature.

3. Tuber Diameter (mm)

Average measurement data of bulb diameter (mm) in shallot plants (Allium ascalonicum L) with SOF and LOF administration which have been tested for mean differences using the multiple range test (Duncan). Based on the analysis of variance on the parameters of bulb diameter (mm) in shallot plants, it was found that the provision of SOF and LOF had a very significant effect. The results of the average tuber diameter (mm) with the provision of SOF and LOF after testing the average difference using the Duncan Distance Test can be seen in Table 3.

Table 3. Average Tuber Diameter (mm) Due to SOF and LOF Application.

Treatment	Tuber Diameter (mm)
Solid Organic Fertilizer (P)	
P0 (0 kg/plot)	6,38cC
P1 (1.5 kg/plot)	6,95bB
P2 (2.5 kg/plot)	7,38bAB
P3 (3.5 kg/plot)	8,00aA
Liquid Organic Ferlilizer (C)	
C0 (0 ml/liter water/plot)	6,53cC
C1 (250 ml/liter water/plot)	6,89cC
C2 (500 ml/liter water/plot)	7,59abAB
C3 (750 ml/liter water/plot)	7,70aA

Description: In the Multiple Range Test (BMRT), numbers in the same column followed by letters are significantly different at the 5% level (lowercase letters) and significantly different at the 1% level (capital letters).

In Table 3 above, the provision of SOF has a very significant effect on the tuber diameter (mm). The highest average was found in the 3.5 kg/plot (P3) treatment, namely 8.00 mm and the lowest was 0 kg/plot (P0), namely 6.38 mm. The results of the regression analysis of SOF administration on tuber diameter (mm) showed a linear relationship. LOF administration had a very significant effect on tuber diameter (mm). The highest average was found in the 750 ml/liter water/plot (C3) treatment, namely 7.70 mm and the lowest was 0 ml/liter water/plot (C0), namely 6.53 mm. The results of the regression analysis of LOF provision on tuber diameter (mm) showed a linear relationship. According to [29], potassium plays a role in the process of photosynthesis to produce organic compounds which are then transferred to storage organs such as tubers and improve tuber quality. Magnesium can activate enzymes needed by plants to make starch and protein.

4. Dry tuber production (g)

Average measurement data of dry bulb production (g) in shallot plants (Allium ascalonicum L) with the provision of SOF and LOF which have been tested for mean differences using the multiple range test (Duncan). Based on the analysis of variance on the dry bulb production parameter (g) in shallot plants, it was found that the administration of PAP and PAC had a very significant effect. The average results of dry tuber production (g) with SOF and LOF administration after testing the average difference using Duncan's Distance Test can be seen in Table 4.

Table 4. Average Dry Tuber Production (g) Due to SOF and LOF Application.

Treatment	Dry Tuber Production (g)
Solid Organic Fertilizer (P)	
P0 (0 kg/plot)	654,88dD
P1 (1.5 kg/plot)	742,63cC
P2 (2.5 kg/plot)	849,50bB
P3 (3.5 kg/plot)	939,50aA
Liquid Organic Ferlilizer (C)	
C0 (0 ml/liter water/plot)	646,00cC
C1 (250 ml/liter water/plot)	809,75bcB
C2 (500 ml/liter water/plot)	834,13bB
C3 (750 ml/liter water/plot)	896,63aA

Description: In the Multiple Range Test (BMRT), numbers in the same column followed by letters are significantly different at the 5% level (lowercase letters) and significantly different at the 1% level (capital letters).

Table 4 above shows that the provision of SOF has a very significant effect on dry tuber production (g). The highest average weight was in the 3.5 kg/plot (P3) treatment, namely 939.50 g and the lowest was 0 kg/plot (P0), namely 654.88 g. The results of the regression analysis of SOF on dry tuber production (which) showed a linear relationship. LOF administration had a very significant effect on dry tuber production (g). The heaviest average was found in the 750 ml/liter water/plot (C3) treatment, namely 896.63 g and the lowest was 0 ml/liter water/plot (C0), namely 646.00 g. This is because the high SOF and LOF are stored in reproductive organs such as tubers, so the tubers look very heavy [30].

5. Conversion of Shallot Production per Hectare (kg)

The conversion parameter of shallot production per hectare (kg) is the cultivated shallot production calculated as an average of all treatments carried out to see the production that has been obtained. The conversion of production per (ha) shallot plant is as follows:

Table 5. Average Conversion of Shallot Production per Hectare (kg) with SOF and LOF Application.

Treatment	Conversion of Shallot Production per Hectare (kg)
Solid Organic Fertilizer (P)	
P0 (0 kg/plot)	6548.75cC
P1 (1.5 kg/plot)	7426.25cC
P2 (2.5 kg/plot)	8495.00bB
P3 (3.5 kg/plot)	9395.00aA
Liquid Organic Ferlilizer (C)	
C0 (0 ml/liter water/plot)	6460.00cC
C1 (250 ml/liter water/plot)	8097.50bB
C2 (500 ml/liter water/plot)	8341.25aA
C3 (750 ml/liter water/plot)	8966.25aA

Description: In the Multiple Range Test (BMRT), numbers in the same column followed by letters are significantly different at the 5% level (lowercase letters) and significantly different at the 1% level (capital letters).

Table 5 above shows that the provision of SOF has a very real effect on the conversion of shallot production per hectare (kg). The highest average was found in the 3.5 kg/plot (P3) treatment, namely 9395.00 kg and the lowest was 0 kg/plot (P0), namely 6548.75 kg. The results of the regression analysis of SOF provision on the conversion of shallot production per hectare (kg) showed a linear relationship. The provision of LOF has a very significant effect on the conversion of shallot production per hectare (kg). The highest average was found in the 750 ml/liter water/plot (P3) treatment, namely 8966.25 kg and the lowest was 0 ml/liter water/plot (P0), namely 6460.00 kg. The results of the regression analysis of LOF provision on the conversion of shallot production per hectare (kg) showed a linear relationship. Calculation of the conversion of shallot (*Allium ascalonicum* L) production per hectare shows that the average conversion yield of shallots was highest in the P3 and C3 treatments. This proves that the use of agricultural waste materials can increase plant growth both vegetatively and generatively optimally. Plant dry weight is an indicator that plants accumulate during photosynthesis and is a synthesis of almost all the processes that the plant goes through. The high conversion of production per hectare is the accumulation of dry weight at each treatment level, this shows that the absorption of water and nutrients which are raw materials for photosynthesis and metabolism can run smoothly so that the photosynthesis produced is also high and stored in the generative organs so that it can be seen that the weight of the tubers is quite heavy [31].

Conclusion

The study's results on the treatment of solid organic fertilizer and liquid organic fertilizer can increase the growth and production of shallots. The best treatment is 3.5 kg/plant for solid organic fertilizer and 750 ml/liter of water/plot for liquid organic fertilizer. This study is one of the solutions to the limited availability of fertilizer and the high price of fertilizer in Indonesia, so that shallot farmers can produce organic fertilizer independently at a low cost, and most importantly, the availability of organic waste/garbage around the farmer's land environment. This study needs to be continued using solid and liquid organic fertilizers at a higher level until the optimal point is obtained for the growth and production of shallots.

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