Respons growth and production of shallot (Allium ascalonicum L.) on Complementary Liquid Fertilizer (CLF) dosage and interval of application time

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Abstract. Shallot is one of the agricultural commodities whose production needs to be increased in the national food security program framework. One effort to increase yield is by conducting cultivation techniques including, fertilization. The study was objective at determining the dose of complementary liquid fertilizers (LCF) and interval application time and their interactions to increase the growth and yield of shallots. The study was conducted in Lampoko Village, Barebbo District, Bone Regency, in April-June 2018. The experiment used a factorial randomized block design with two factors. The first factor was the CLF dose at three levels (1.0, 2.0, and 3.0 ml L\(^{-1}\)) and the second factor was an interval of application time at three levels (every 5, 7, and 9 days). The results showed that the treatment of CLF dose significantly affected plant height and number of leaves. The treatment of the interval of application time significantly involves the number of bulbs, bulbs' diameter, fresh bulbs weight, and dry bulbs weight. In general, the best growth and production of shallots were obtained in the treatment of LCF with a dose of 2.0 ml L\(^{-1}\) at an interval of 5 days for once application.

1. Introduction
Shallots (Allium ascalonicum L.) is one of the vegetable commodities that have essential meaning for the community, both from their high economic value and nutritional content. In line with the population growth and the increasing demand for shallot commodities, shallot commodities’ production and quality must always be increased through intensification and extensification. As a horticultural commodity widely consumed by the public, the potential for developing shallots is still wide open for domestic needs and foreign markets [1].

This suggests that shallot production results must be pursued immediately by applying advanced technology so that shallots can keep up with the increasing demand in quantity and quality. In connection with the high economic value, the need for shallots in Indonesia from year to year has increased by 5%. In line with the increasing number of all populations, increasing every year, high production is needed, while shallot production decreases [2]. Changes in production prove that domestic shallot production has not been stable [3].
Directorate General of Horticulture [4] stated that total shallot production in South Sulawesi 129.181 ton in 2017 decreased to 92,392 tons in 2018, decreasing around 28%. Increasing production can be done using correct cultivation techniques and proper fertilization, namely, dose and target. So that production results can be maximized in the cultivation of these plants. One of the organic fertilizers that can increase crop yield is liquid complimentary fertilizers (CLF).

Liquid complimentary fertilizers are liquid fertilizers that function as complementary fertilizers that provide more nutrition to the leaves and stems [5]. LCF contains macro and micronutrients high enough due to natural organic compounds containing active living cells and safe environments.

LCF is very useful in its use and can save the use of inorganic fertilizers. LCF is the extraction of organic material from livestock waste, plant waste, and natural waste that is processed while prioritizing environmentally friendly technology, containing organic macro and micro essential nutrients that can meet the needs of plants in their growth, can also increase soil pH and be able to reduce the level of pest attack as well as destroying inorganic fertilizer residues.

LCF is in the form of a liquid that can make it easier for plants to absorb the nutrient elements than other solid fertilizers. In its application, besides being given through the soil, which is then absorbed by plant roots, LCF can also be applied through plant leaves to support optimal nutrient absorption.

LCF interval needs to be considered to match plant need. The research results conducted by [6] that giving 100 ml of L-1 POC Coober Plus should be given once every one week is providing a better effect than giving two weeks for the growth and yield of shallots (Allium cepa L.). Based on the discussion above, a study was conducted to determine the right combination of LCF dose and affliction time interval to increase yields and shallot production. This study aimed was to determine the dosage of LCF and the interval LCF and their interaction to influence the growth and production of shallot.

2. Materials and Methods
2.1. Experimental Site
The research was conducted in Lampoko Village, Barebbo District, Bone Regency, South Sulawesi, with an altitude of 10 m above sea level, an alluvial soil type with a pH of 5.5 - 7.0. It was carried out from April to June 2018.

2.2. Planting Materials
The materials used are Bima variety shallot bulbs as plant material, LCF, pesticides, and other supporting materials. The tools used are a hoe to process the planting medium, a bucket, a bucket to water the plants, a meter to measure plant height, an analytical scale to weigh plant production, randomize samples for signs from plants that are samples, a calliper to measure bulbs diameter, and stationery to write observations.

2.3. Implementation in The Field
The land is ploughed and harrowed, crop plots are made with as many as 27 plots in size 120 cm wide, and extended 100 cm with the spacing of 20 cm x 20 cm and spacing each plot is 40 cm. Planting is carried out using shallot bulbs measuring 5-6 grams, the tips of the tubers are cut by 1/3 part to accelerate the release of shoots.

LCF was given to plants from the age of 5, 7 and 9 days after planting based on the treatment interval of application time with the dose 1.0, 2.0, and 3.0 ml L⁻¹ based on the treatment. Maintenance is carried out by watering two times a day in the morning and evening if it does not rain and spraying with vegetable pesticides to prevent pests and diseases. Harvesting is done when the shallot is 60 days old and drying under the hot sun for ± 15 days until the shallot is dry.

2.4. Experimental Design, Data Collection, and Analysis
The study's design was a Factorial pattern (3x3), Randomized Completely Block Design with three replications. Each experimental unit consisted of 10 sample plants. The first factor consisted of four
LCF dose levels (1.0, 2.0, and 3.0 ml), and the second factor has consisted of three levels of interval LCF (every 5, 7, and 9 days). Experimental parameters were planted's the height at the age of 7, 14, 21, 28, 35, 42 and 49 DAP, the number of leaves at the age of 7, 14, 21, 28, 35, 42 and 49 DAP, the number of bulbs, bulb diameter, fresh bulb weight, dry bulb weight, and yield potential. The data were then analyzed statistically with the analysis of variance (ANOVA). Data were analyzed using SPSS (Statistical Package for the Social Sciences) version 22.0 to determine the effect of treatment. If the treatment has a significant impact, further analysis was done using Duncan New Multiple Range Test (DNMRT) at the 5% significant level.

3. Result and Discussion

3.1. Effect of LCF dosage on growth and yield of shallots

The results showed that the LCF dose significantly affected the height of shallot plants aged 14-42 DAS, the number of leaves at 14, 21, 28, and 42 DAS, but did not significantly affect plant height 7 and 49 DAS and the number of leaves. At plant age 7, 35, and 49 DAS. The LCF dose also had no significant effect on bulbs' parameters, bulbs diameter, bulbs fresh weight and bulbs dry weight.

The LCF dose of 2.0 ml L\(^{-1}\) showed the highest plant height compared to the LCF dose of 1.0 ml L\(^{-1}\) and 3.0 ml L\(^{-1}\), at each observation (7-49 DAS). The highest plant height was obtained at the LCF dose of 2.0 ml L\(^{-1}\) when the plants were 42 DAS with a value of 32.92 cm. Provision of LCF can help supply nutrients, especially nitrogen in photosynthesis, to fill the maximum amount of food, and the results can be used for vegetative growth of plant stems. LCF plays a role in donating N and Mg elements which can increase plant growth. Soil roots can easily intercept every soil pore. The roots will absorb the water-bound by organic matter; then the water is used as a nutrient solvent and cell elongation and division, which will result in increased plant height. Organic matter is directly a source of nutrients N, P, K, and other essential nutrients [7].

| Parameter                        | LCF Dose (ml) |    |    |    |
|----------------------------------|---------------|----|----|----|
|                                  | 1.0           | 2.0| 3.0|
| Plant height (cm)                |               |    |    |    |
| 7 DAP                            | 10,17         | 10,76| 10,41|   |
| 14                               | 14,40 c       | 16,35 a| 15,31 b|   |
| 21                               | 19,17 b       | 20,02 a| 18,63 b|   |
| 28                               | 22,31 c       | 24,54 a| 23,38 b|   |
| 35                               | 26,53 b       | 28,16 a| 27,16 b|   |
| 42                               | 31,26 a       | 32,92 a| 31,98 a|   |
| 49                               | 36,03         | 36,72| 36,18|   |
| Number of leaf (leaf)            |               |    |    |    |
| 7 DAP                            | 5,1           | 5,4 |    |    |
| 14                               | 8,4 b         | 9,4 a| 9,1 a|    |
| 21                               | 13,6 b        | 15,2 a| 14,7 b|   |
| 28                               | 16,3 b        | 18,1 a| 17,2 b|   |
| 35                               | 20,1          | 20,7 | 20,1|   |
| 42                               | 24,9 c        | 28,4 a| 26,6 b|   |
| 49                               | 27,1          | 27,4 | 27,2|   |
| Number of bulbs (bulbs)          |               |    |    |    |
| 6,1                              | 6,4           | 6,2 |    |    |
| Diameters of bulbs (mm)          |               |    |    |    |
| 21,19                            | 21,91         | 21,22|    |    |
| Fresh bulbs weight (gr)          |               |    |    |    |
| 15,65                            | 16,02         | 15,98|    |    |
| Dry bulbs weight (gr)            |               |    |    |    |
| 14,32                            | 15,08         | 14,86|    |    |
| Yield potential (t ha\(^{-1}\))  |               |    |    |    |
| 4,15                             | 5,75          | 4,84|    |    |

Note: The numbers followed by the same letter in the same column are not significantly different from the DMRT at the level of 5% (DAP = day after planting)
As well as plant height, the highest number of leaves for each observer (7-42 DAS), LCF dose of 2.0 ml L\(^{-1}\) gave the highest number of leaves compared to other LCF doses (1.0 ml L\(^{-1}\) and 3.0 ml L\(^{-1}\)). The highest number of leaves was obtained at the LCF dose treatment of 2.0 ml L\(^{-1}\), namely 28.4 strands at the plant 49 DAS age. Leaves are the main organ to absorb solar radiation and carry out photosynthesis in plants so that the resulting assimilation affects plant weight [8]. Meanwhile, according to [9], environmental conditions significantly affect the height and number of leaves on a plant. The average growth and yield of shallots at the LCF dose treatment can be seen in Table 1.

![Figure 1. Increase in plant height of shallot plants based on dose of LCF](image1.png)

![Figure 2. Increase in number of leaves of shallot plants based on dose of LCF](image2.png)

Figures 1 and 2 show about the effect of treatment on high growth rates shallot plants based on the plant's age of the plant, generally there is an increase in plant height and a number of leaves up to
week 7 (49 DAS) forming a sigmoid curve. In general, the increase in plant height and number of leaves stops when it reaches the 6th week (42 DAS).

Provision of LCF at a dose of 2.0 ml L⁻¹ has fulfilled the nutrients needed by shallots, especially nitrogen and phosphorus. Nitrogen functions as a constituent of enzymes and enzyme molecules for protein synthesis and carbohydrate metabolism, while phosphorus plays a role in forming chlorophyll and helps translocation in the soil [10]. Increasing chlorophyll can promote cell division and cell differentiation, where cell division is closely related to plant organs' addition [11].

The fertilizer dosage in fertilization must be correct, meaning that the dose is not too little or too much, which can cause the waste or damage plant roots [12]. If the fertilizer dose is also, low, there is no effect on plant growth, while too much dosage can disturb the nutrient balance and poison plant roots. Providing less or excessive fertilizer will affect plant growth [13]. Plants need adequate amounts of macro and micronutrients, but if the nutrients are given excessively, they can inhibit plant growth.

3.2. Effect of LCF application time intervals on the growth and yield of shallots

The results showed that the interval application time for LCF had no significant effect on plant height and number of leaves for each observation, but had a substantial impact on the number of bulbs, bulbs diameter, and had a very significant effect on fresh bulbs weight and dry bulbs weight. The time interval for applying fertilizer is closely related to environmental factors. If given during the rain, the fertilizer will be washed off to absorb nutrients is not optimal. Using fertilizers must also be done appropriately so that the fertilizers given are not wasted. Therefore, application time is an essential component in fertilization [14]. The average growth and yield of shallots at the LCF treatment interval can be seen in Table 2.

| Parameter                        | 5 DAP | 7 DAP | 9 DAP |
|----------------------------------|-------|-------|-------|
| Plant height (cm)                |       |       |       |
| 7 DAP                           | 10,63 | 10,43 | 10,27 |
| 14                              | 15,78 | 15,16 | 15,13 |
| 21                              | 19,40 | 19,33 | 19,11 |
| 28                              | 23,94 | 23,06 | 23,23 |
| 35                              | 27,66 | 27,09 | 27,10 |
| 42                              | 32,13 | 32,00 | 32,02 |
| 49                              | 36,69 | 36,23 | 36,02 |
| Number of leaf (leaf)           |       |       |       |
| 7 DAP                           | 5,5   | 5,3   | 5,2   |
| 14                              | 9,1   | 9,0   | 8,9   |
| 21                              | 14,7  | 14,5  | 14,3  |
| 28                              | 17,6  | 17,0  | 17,0  |
| 35                              | 20,5  | 20,2  | 20,2  |
| 42                              | 26,9  | 26,2  | 26,0  |
| 49                              | 28,3  | 28,36 | 28,28 |
| Number of bulbs (bulbs)         |       |       |       |
| 6,32 a                          | 5,80 b | 5,13 b |
| Diameter of bulbs (mm)          |       |       |       |
| 22,02 a                         | 21,41 b | 20,89 c |
| Fresh bulbs weight (gr)         |       |       |       |
| 16,31 a                         | 15,97 b | 15,02 b |
| Dry bulbs weight (gr)           |       |       |       |
| 15,12 a                         | 14,78 b | 14,00 b |
| Yield potential (t ha⁻¹)        | 6,01  | 5,86  | 5,82  |

Note: The numbers followed by the same letter in the same column are not significantly different from the DMRT at the level of 5% (DAP = day after planting)

The application of LCF once every five days resulted in the highest number of bulbs compared to the other interval application (7 and 9 days), namely 6.32 and the lowest was obtained in the interval treatment of giving LCF once in 9 days, namely 5.13. Giving LCF, which is done every five days, can
stimulate the number of bulbs’ growth. This is because plants get more frequent nutrient intake, which immediately affects plant metabolism [15]. Shallot bulbs are formed from the leaf base, which swells in layers to create a pseudostem as layered bulbs that function as a food storage organ. Provision of LCF with complete nutrient content will stimulate photosynthesis, and the result in the form of carbohydrates will be transported to all parts of the plant organs.

Interval of LCF gave the highest bulbs diameter in the 5-days with a value of 22.02 mm, while the lowest result was obtained at the 9-day with a value of 20.89 mm. This is due to the ability of organic matter from LCF to improve soil structure, so that root uptake runs well to produce tubers. Soil roots can easily intercept every soil pore. Nitrogen in shallot plants affects the yield and quality of bulbs. Lack of nitrogen will cause small bulbs size and low water content, while excess nitrogen will cause bulbs size to be large and water content is high but less pithy and easy to porous. Nitrogen can affect the yield and quality of shallot bulbs [16].

Phosphorus is a component of enzymes, proteins, ATP, RNA, DNA, and Putin, which have essential functions in photosynthesis, the use of sugar and starch, and energy transfer. There are no other nutrients that can replace P’s part in plants to get enough P to increase root development and plant carbohydrate content, ultimately increasing plant growth and yield. Potassium functions as a photosynthetic catalyst which affects increasing yield. Deficiency of K in shallots will inhibit growth, decrease resistance to disease, and reduce yield [17]. P deficiency causes slow, weak, and stunted plant growth and development [18], while depletion of elemental K will inhibit essential processes such as sugar transport from leaves to bulbs, enzyme activity, protein synthesis, and cell enlargement, which in the end will determine the results and the quality of the products [19].

The application of LCF in 5 days produced the highest fresh weight of bulbs with a value of 16.31 g when compared to other application times, while the lowest fresh weight of bulbs was obtained at the interval treatment of giving LCF once in 9 days with a value of 15.02 g. The shorter the time interval for giving LCF, the more nutrients available for plants will increase plant growth. This is presumably because the provision of LCF that contains sufficient N can spur vegetative growth for the better to affect the yield of shallots. [20] stated that nitrogen can accelerate the photosynthesis process so that the formation of leaf organs becomes faster.

Plants need N nutrients to stimulate plants’ vegetative growth, which will increase the weight of fresh plants [12]. According to [21], a plant will grow and flourish if the nutrients provided can be absorbed by a plant and in a form suitable for root absorption and low conditions. The application of LCF in 5 days produced the highest dry weight of bulbs with a value of 15.12 g compared to other application times, while the lowest dry weight of bulbs was obtained at the interval of LCF once in 9 days with a value of 14.00 g. Plant dry weight is a measure of plant growth and development because dry weight reflects the accumulation of organic compounds successfully synthesized by plants. Plant dry weight also reflects the nutritional status of a plant. It is also an indicator that determines whether a plant's growth and development is profitable or not, so it is closely related to nutrient availability [22]. Meanwhile, according to [23], dry plant weight shows plant activity and tissue water content, nutrients, and plant metabolism.

3.3. The effect of the interaction of LCF dose with LCF intervals on the growth and yield of shallots

The interaction between the LCF dose and the time interval did not significantly affect plant height, number of leaves, tuber diameter, wet tuber weight, and dry tuber weight, but had a significant effect on shallots’ yield potential. The highest yield potential of shallots was obtained was LCF dose of 2.0 ml L⁻¹ with a time interval of 5 days with a value of 6.43 t ha⁻¹. Potential interactions of shallot yield can be seen in Table 3 and Figure 3.
Table 3. The interaction between the LCF dose and the time interval on the yield potential of shallots

| LCF Dose (ml) | LCF interval (days) | 5  | 7  | 9  |
|---------------|---------------------|----|----|----|
| 1,0           | 5,53 Bb             |    |    |    |
| 2,0           | 6,43 Aa             |    |    |    |
| 3,0           | 6,08 Aa             |    |    |    |

Notes: Numbers followed by the same letter in (capital letters viewed by row and lower case letters viewed by column) are not significantly different at the 0.05 DMRT test level.

Figure 3. The interaction between LCF doses and the interval application time on the potential yield of shallots

The application of organic fertilizers can increase organic matter in the soil and make the soil looser so that root development can better absorb nutrients and organic matter. According to [24], the application of organic matter will form granules that bind the clay so that the soil becomes more porous so that the roots can easily penetrate the soil to absorb nutrients.

The bulbs that are formed are influenced by the number of nutrients that plants can absorb, with the addition of organic matter will affect the soil's properties, one of which is the loose and the soil's ability to bind nutrients. Suppose the soil conditions are to absorb nutrients and water from the soil so that plant growth will be optimal. The number of leaves and leaf area influences the assimilation yield. The assimilation results in shallot plants during the generative phase are accumulated in the formation of bulbs [25].

4. Conclusion
LCF significantly affects plant height at 14-42 DAP and number of leaves at 14,21,28, and 42 DAP. Interval of application time treatment significantly affected bulbs number, bulbs diameter, bulbs fresh weight, and bulbs dry weight. The interaction between the LCF doses and an interval of application time significantly affected shallots' potential yield. The best growth and production of shallots were obtained in the treatment of LCF with a dose of 2,0 ml L⁻¹ at an interval of 5 days for once application with a value of 6,43 t ha⁻¹.
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