SHALLOT (*Allium ascalonicum* L.) GROWTH AND YIELD RESPONSE TO CONCENTRATION AND APPLICATION TIME OF LIQUID ORGANIC FERTILIZER

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Abstract

Shallot (Allium ascalonicum L.) is an annual plant that is widely used as a mixture of cooking spices. Shallot plants can grow in is 0-400 m above sea level, air temperature between 25-32^{0}C and rainfall of 1000-1500 mm per year. Therefore it is necessary to cultivate shallots through organic fertilization in the form of Liquid Organic Fertilizer (LOF) and followed by right time of LOF application. This study aims to determine the interaction of concentration and application time of LOF, determine the optimum concentration of LOF, and determine the appropriate application time of LOF. This research was conducted during March 2021 – May 2021 in Kandang Limun Village, Bengkulu City. This study used a completely randomized design of 2 factors and 3 replications. The first factor was the concentration of LOF which consisted of 4 levels, namely: K_0: 0 ml l^- ; K_1 = 3 ml l-, K2 = 6 ml l^- and K_3 = 9 ml l^-. The second factor is LOF application time which consists of 3 levels, namely: W_1 = 1 Week after Planting (WAP), W_2 = 2 WAP, W_3 = 3 WAP. Afterward there were 12 treatment combinations and replicated 3 times thus consist of 36 experimental units. Each experimental unit consisted of 3 sets then there were 108 polybags. The data obtained were analyzed using Analysis of Variance at the 5% level of the F test. The results showed that there was no interaction between concentration and time of application of LOF on the growth and yield of shallots. There was no significant effect on the concentration of LOF for the growth and yield of shallots. There was no significant effect on the timing of application for the growth and yield of shallots.

***Keyword: shallot, liquid organic fertilizer, time, concentration*.**

1. INTRODUCTION

Shallots (Allium ascalonicum L) are annual plants that are often used as a spice in cooking. Apart from being used as a spice, shallots are also sold in processed forms such as extracts, powder, essential oils, and are even used as medicine to lower blood sugar, prevent blood clots, lower blood pressure, lower cholesterol levels, and improve blood flow. According to Suriani (2012), as an annual crop that is widely consumed by the public, shallots have broad development potential for both domestic and international needs. Based on data from the Central Statistics Agency (2019), shallot production in Bengkulu province increased from 2016 to 2018. In 2016, shallot production reached 351 tonnes, increased to 478 tonnes in 2017, and reached 911 tonnes in 2018 However, in 2019, production decreased to 523 tons.

There are several factors that cause low shallot production yields, including the use of non-uniform and low quality seeds, as well as low levels of soil fertility (Purnomo, 2007). Low soil fertility in many areas in Bengkulu requires the application of improved technology to increase shallot production, one of which is through fertilization. Fertilization is also an alternative to increase the organic material content needed in shallot cultivation.

Organic fertilizer is divided into two types, namely solid organic fertilizer and liquid organic fertilizer. However, for onion plants, liquid organic fertilizer is considered more effective and can increase soil fertility (Hadisuwito, 2012). Liquid organic fertilizer is a type of fertilizer in liquid form that dissolves easily in the soil and contains important elements for plant growth. According to Syefani and Lilia (2003), liquid organic fertilizer has many advantages, including containing microorganisms that are rarely found in solid organic fertilizer in dry form.

Liquid organic fertilizer (LOF) is a type of fertilizer that can be applied to leaves and soil, contains complete macro and micro nutrients, and can reduce the use of chemical fertilizers (Hanisar and Bahrun, 2012). The LOF content can improve the consistency of hard soil and dissolve SP-36 quickly. Apart from that, LOF is able to accelerate plant growth, reduce disease attacks, has no side effects that are detrimental to plants and the environment, and is safe for farmers (Nusantara, 2018). LOF stimulates an increase in compounds that help plants increase disease resistance. However, the use of pesticides is still necessary if disease attacks exceed the threshold, because LOF only reduces pest and disease attacks, not eliminates them completely (Kardinan, 2011). One disease that can cause major losses is purple spot (trotol) caused by the fungus Alternaria porri (Nur, 2005).

Providing liquid organic fertilizer (LOF) often can cause excessive consumption and waste of fertilizer. Therefore, it is necessary to set the right time to apply fertilizer. According to research by Jamilah *et al*. (2017), the highest fresh tuber weight and dry tuber weight in shallot plants was found at once a week fertilizer application intervals, with fresh tuber weight reaching 56.80 g and dry tuber weight reaching 46.18 g. Research by Sara *et al*. (2020) showed that the highest number of tubers was found in the combination of control gibberellin treatment with a LOF interval of every 14 days. Nugrahini (2013) stated that the use of liquid organic fertilizer on shallot plants had a significant influence on plant height at 20, 40 and 60 days after planting (DAP), the number of leaves at 20, 40 and 60 DAP, and the number of tillers at 20, 40 and 60 days after planting. age 40 and 60 DAP, tuber weight per plot, and tuber production (Nusantara, 2018).

2. RESEARCH METHODS

This research was carried out from March to May 2021 in Kandang Limun Village, Bengkulu City, at an altitude of ±5 meters above sea level. The materials used in this research include shallot bulbs of the Batu Ijo variety, water, labels, polybags (40x40 cm), liquid organic fertilizer that has received permission from the Department of Agriculture, Urea, SP36, and KCl.

The equipment used includes a hoe, measuring tape, raffia rope, machete, stick, stake, waring, calculator, camera, gembor, scissors, digital scales, 1 m ruler, books and writing tools. This research used a Completely Randomized Design (CRD) with 2 factors and 3 replications. The first factor is the concentration of liquid organic fertilizer which consists of four levels, namely: K0: 0 ml I-; K1 = 3 ml l-, K2 = 6 ml l- and K3 = 9 ml l-. The second factor is the time to apply LOF which consists of 3 levels, namely: W1 = 1 MST (MST), W2 = 2 MST, W3 = 3 MST. Then 12 treatment combinations were obtained and repeated 3 times to obtain 36 experimental units. Each experimental unit consists of 3 sets and there are 108 polybags. The data obtained were analyzed using Variance Analysis at an F test level of 5%.

The stages of conducting the research began with soil analysis, the nutrients analyzed were N, P, K, C-organic and soil pH, the soil was analyzed at the Soil Science Laboratory, Bengkulu University. Then the planting media used is a mixture of top soil and husk charcoal in a ratio of 2:1. First, take the soil, then sift it first and when finished sifting, then put it in the warehouse to air dry for 1 week. Then add the mixed charcoal husk and stir until homogeneous before placing it in a polybag.

Next is filling the polybag with soil mixed with 8 kg of husk charcoal. The size of the polybag used is 10 kg (40 cm x 40 cm) with a diameter of 30 cm. The container is not filled completely, but leave 5 cm of the top of the polybag and fold it, then arrange it according to the experimental plan.

Then the preparation of shallot seeds of the Batu Ijo variety is selected with a relatively uniform shape and size, healthy and good with the criteria of shiny color, not porous and without wounds, weighing 3-4 grams/bulb, medium sized with a diameter of 1, 5–2 cm symmetrical tuber shape, not peeling, free of pest organisms. The selected seeds are then cut off 1/4 of the tip of the tuber using a knife. Cutting the top of the seedlings is done to facilitate shoot growth and ensure uniform growth when planting.

Next is the installation of shade and labeling which aims to make it easier to provide treatment and observation in each experimental unit. Labeling using a plastic folder cut into a rectangular shape is written using a permanent marker. The next stage is planting with the tubers planted in an upright position in the planting hole by immersing all parts of the tuber so that they are flush with the soil surface.

Fertilize by providing Urea, SP36, and KCl as much as 1.8; 1.3 and 0.9 grams/polybag respectively. Fertilizer is given at planting time, except Urea is given twice and applied at planting time and 3 WAP. Fertilizer is applied around the plant roots. LOF is given in the morning according to the treatment, namely 1 WAP, 2 WAP and 3 WAP. LOF is given by spraying onto plants with volumes of 3, 6, and 9 ml per plant. Replanting is carried out after 1 WAP by replacing plants that do not grow with prepared spare tubers. Next is manual weeding by pulling out weeds in and around the polybags, when the plants are 2 WAP until harvest.

Pest and disease control is carried out if symptoms are found on the plants. The final stage is harvesting when the plants are 60-70 days old. The physical characteristics of shallot plants ready for harvest include signs of 60% soft stem necks, drooping plants, and yellowing leaves (Sumarni and Hidayat, 2005). The plant variables measured were plant height (cm), number of leaves per clump (pieces), fresh stem weight (g), number of tubers per clump (g), wet weight of tubers per clump (g), tuber diameter (cm). All observational data were analyzed using analysis of variance with an F test at 5% level. Results that have a real effect are further tested using Orthogonal Polynomials.

The variance analysis results indicate that neither the concentration of liquid organic fertilizer (LOF) nor the timing of its application had a significant interaction with any of the observed variables (Table 1). Specifically, variations in LOF concentration did not yield significant effects on plant height, number of leaves, fresh stem weight, number of clump tubers, wet weight of clump tubers, or tuber diameter. Similarly, the timing of fertilizer application did not result in significant changes in these measured variables.
Table 1 provides a summary of the F-calculated growth and yield response of shallot plants to different concentrations and application times of liquid organic fertilizer.

Measured Variables	Liquid Organic Fertilizer Concentration	Application Time	Interaction	diversity coefficient (%)
Plant height	$0{,}87^{ns}$	$2{,}87^{ns}$	$0{,}85^{ns}$	6,58
Number of Leaves•	$0{,}59^{ns}$	$0{,}29^{ns}$	$1{,}35^{ns}$	12,32
Fresh Start Weight•	$0{,}44^{ns}$	$0{,}39^{ns}$	$2{,}09^{ns}$	14,43
Number of Tubers•	$0{,}99^{ns}$	$0{,}53^{ns}$	$0{,}84^{ns}$	14,43
Weight of fresh tubers per hill•	$0{,}91^{ns}$	$0{,}97^{ns}$	$2{,}12^{ns}$	16,67
Tuber Diameter	$0{,}97^{ns}$	$0{,}22^{ns}$	$1{,}24^{ns}$	17,13

Note: ns = no significant effect at the 5% level; • = Transformed data
In the summary analysis of variance results (Table 1), it's evident that there's no interaction between LOF concentration and application time across all measured variables. This suggests that each treatment factor independently influences the outcomes without any mutual influence.
Table 2 displays the average values of growth and yield variables for shallot plants, including plant height, leaf count, fresh stem weight, bulb count, fresh tuber weight, and tuber diameter.

Treatment	Plant Height (cm)	Number of Leaves (pieces)	Wet Weight of Bulbs (g)	Number of Bulbs (tubers)	Fresh Weight of Tubers (g)	Tuber Diameter (mm)
K_0W_1	44,72	21,44	115,55	3,88	69,22	30,45
K_0W_2	40,77	15,55	88,55	2,55	47,55	29,62
K_0W_3	42,72	19,22	99,44	3,55	60,88	29,27
K_1W_1	43,88	23,44	126,22	4,55	72,44	31,89
K_1W_2	40,16	19,55	93,77	3,66	46,77	27,32
K_1W_3	39,61	17,11	76,55	3,55	39,44	25,41
K_2W_1	41,88	15	79,55	2,66	41,22	30,12
K_2W_2	41,11	16,55	83,44	3,11	46,11	30,16
K_2W_3	43,05	21,55	131	3,66	75,44	34,27

K_3W_1	41	15,55	70,44	3,33	37,11	23,64
K_3W_2	38,88	18,22	92,66	3,33	46,66	28,52
K_3W_3	42,55	17,77	97	3,22	52,55	31,63

Note: K0 = Control, K1 = 3ml/L K2 = 6ml/L, K3 = 9ml/L W1 = 1MST, W2 = 2MST, W3 = 3MST

2.1. Response of Shallot Plant Yields to Liquid Organic Fertilizer Concentration

Below is presented the average data on the observation variables of fresh fruit weight, number of tubers, fresh tuber weight per cluster, bulb diameter and LOF concentration in shallot growth.

Based on the average data above, it is known that the control treatment is the treatment that produces the highest fresh tuber weight, namely 101.18 grams and the highest fresh tuber weight, namely 59.22 g. Treatments K1, K2 and K3 have not been able to exceed the results from K0. This is thought to be because the initial condition of the media (soil and husk charcoal) already has sufficient microorganisms and nutrients in the form of Nitrogen nutrients from the soil and husk charcoal provided. According to Triadiawarman et al. (2022), nitrogen (N) is used by plants for overall plant growth and also functions for the synthesis of amino acids and proteins in plants. Apart from that, it increases vegetative growth and is the formation of chlorophyll which affects the green substance of leaves.

Table 3 Response of shallot Plant Results to Liquid Organic Fertilizer Concentration

Variabel	BBS	JU	BUS	DU
K0	101,18	3,33	59,22	29,78
K1	98,85	3,92	52,88	28,21
K2	98	3,0	54,25	31,52
K3	86,70	3,2	45,44	27,93
Rata-rata	96,18	3,38	52,95	29,36

BBS: Wet Weight of Tubers, JU: Number of Tubers, BUS: Weight of Fresh Tubers, DU: Diameter of Tubers

In addition to the sufficient nitrogen (N) content in the soil, the soil also exhibits a relatively high potassium (K) level, measuring 1.08. As highlighted by Rosmarkan and Yuwono (2002), potassium plays a significant role in tuber formation and functions in carbohydrate formation and transportation, stem strengthening, enhancing seed plumpness and density, improving fruit quality, imparting resistance to pests and diseases, and fostering root development.

However, in terms of the variable "Number of Tubers," it's notable that treatment K1 (3 ml) resulted in the highest tuber count compared to treatments K0, K2, and K3. This indicates that the 3 ml concentration treatment effectively provided adequate nutrients for shallot bulb formation. Nonetheless, genetic factors play a pivotal role in determining tuber count, with the number of tillers and tubers being more genetically influenced than by environmental factors. Research findings by Napitupulu and Winarto (2010) suggest that the application of organic or inorganic fertilizer has minimal impact on shallot plant tiller and bulb counts. This could be attributed to the fact that the number of tillers and bulbs is predominantly determined by genetic variety rather than fertilization methods. The green stone variety typically yields an average of 2-5 tubers.

Moving on to the variable of tuber diameter, the data table indicates that the highest tuber diameter was recorded in treatment K2 (6 ml), reaching 62 mm. Treatments K0, K1, and K3 failed to surpass the results of treatment K2. Although the effect is not significant, at a concentration of 6 ml, plants exhibit the ability to absorb nutrients, especially nitrogen (N) and potassium (K) from the liquid organic fertilizer (LOF). According to Sumiati and Gunawan (2007), the input of N and K is crucial for the generative phase formation. N serves as a building block for proteins, nucleic acids, enzymes, nucleoproteins, and alkaloids, while K aids in the photosynthesis process by forming organic compounds that are then transported to storage organs. This aligns with Prasetiya's statement (2015) that optimal N levels foster a fertile canopy, and adequate K levels facilitate better photosynthate translocation, resulting in superior tuber quality. This notion is further supported by Salisbury and Ross (1999), who assert that potassium activates enzymes essential for starch and protein formation. Additionally, Zulkarnain (2013) suggests that shallot bulb formation is optimized when nutrients are available in optimal conditions.

Organic carbon (C-organic) serves as a crucial indicator of soil quality. Its presence significantly influences soil physical quality and productivity (Komatsuzaki and Ohta, 2007) and helps maintain soil fertility levels, thereby safeguarding soil and water quality in relation to nutrient cycles, water, and biology (Lal, 2004). It's worth noting that the C-organic content in the provided liquid organic fertilizer is 9.69%, which falls into the low category compared to other organic fertilizers. BPTP SUMUT (2020) indicates that the C-organic content required to meet organic fertilizer standards, as per Minister of Agriculture Regulation No.28/Permentan/SR.130/5/2009, should exceed 12%. The relatively low C-organic level in the provided liquid organic fertilizer is a factor influencing the shallot plant growth results, which are not significantly different.

Liquid organic fertilizer is characterized by slow availability (slow release), which means that the nutrients in the LOF are not fully absorbed by shallot plants until the harvest phase when applied after planting. Application of LOF before planting is anticipated to enhance shallot growth and yield.One of the weaknesses of LOF is that it is easily washed and evaporated. This is the basis that when watering the nutrients given to the plants are washed away by the water. Even though liquid organic fertilizer is applied through the leaves, the nature of shallot leaves which stand upright means that most of the concentration given falls to the ground. So the nutrients provided do not work optimally for the plants. This is also the basis that giving concentration has no real effect on the growth and yield of shallot plants.

In general, the factors that influence plant growth and development consist of environmental factors (A'yuningsih, 2017), one of which is humidity. According to the Ministry of Agriculture (2019) the optimum humidity for the growth and development of shallot plants is 50-70%. It is known that humidity at shade temperatures ranges above 70%. if humidity is high, the transpiration rate is low and nutrient absorption is also low. This will reduce the availability of nutrients for the growth of shallot plants so that their growth will be hampered. The development of shallot plants is directed at optimal suitability to environmental physical factors. In this case, it is a factor that directly influences the yield and adaptation of the variety to the growth of shallots.

2.2. Response of Shallot Plant Yields to the Time of Application of Liquid Organic Fertilizer

Below is presented the average data for observation variables: fresh fruit weight, number of tubers, fresh tuber weight per cluster, tuber diameter and LOF concentration in shallot growth.

Based on average data, giving W3 (3MST) provides the best growth in the fresh fruit weight variable, namely 101 grams. when compared with treatment W1 of 97.94 grams and W2 of 89.61 grams. the number of W1 and W2 is smaller compared to treatment W3. Next, the weight of fresh tubers per hill at W3 weighs 57.08 grams. This value is greater when compared to treatment W1 of 55 grams and W2 of 46.77 grams.

Table 4 Response of Shallot Plant Yield to Time of Application of Liquid Organic Fertilizer

Variabel	BBS	JU	BUS	DU
W1	97,94	4	55	29,03
W2	89,61	3	46,77	28,90
W3	101	3	57,08	30,15
Rata-rata	96,18	3	52,95	29,36

Note: BBS: Wet Weight of Tubers, JU: Number of Bulbs, BUS: Weight of Fresh Tubers, DU: Diameter of Tubers

Furthermore, in treatment W3, the tuber diameter was also larger compared to treatments W1 and W2, measuring 30.15 mm as opposed to 29.03 mm and 28.90 mm, respectively. As for the variable "number of tubers," it tended to yield an average of 3 tubers per plant, with treatment W1 (1 week after planting) producing the highest number of tubers at 4 tubers per plant. The variance analysis results (Table 1) indicate that the timing of LOF administration did not yield significantly different effects on all observed variables, including the weight of fresh stems, number of tubers, weight of fresh tubers per stem, and tuber diameter.

Although the differences are not statistically significant, the overall findings from Table 4 suggest that administering LOF at 3 weeks after planting yields better results compared to other timings. There's no substantial difference among the three administration timings, likely because the intervals between LOF applications are not significantly varied, thus having an insignificant impact on LOF spraying. When administering LOF, several factors should be taken into consideration, such as the type and nutrient content of LOF, solution concentration, and administration timing. According to Schroth and Sinclair (2003) as cited in Jumini et al. (2012), plants receiving nutrients in optimal amounts and at the right time tend to grow and develop optimally. This aligns with the notion expressed by Hakim et al. (1986), emphasizing the importance of timing and method in fertilizer application to enhance nutrient absorption efficiency in plants.

Application times at 1, 2, and 3 weeks after planting exhibited no significant effects on all observed variables. This could be attributed to the rapid application of liquid organic fertilizer, preventing shallot plants from efficiently processing the nutrients for growth and yield. Plant nutrient requirements vary throughout growth stages, necessitating varied timing and quantities of fertilization for optimal growth and development.

Single application of LOF treatment can also have consequences, as the recommended administration frequency for the LOF used is more than once. Consequently, plants may not absorb sufficient nutrients, as highlighted by Saptarini et al. (2009), who stress the importance of correctly applying fertilizer according to recommended dosages and application timings. Multiple applications of fertilizer are expected to enhance shallot growth and yield.

3. **CONCLUSIONS**:

There was no significant interaction between LOF concentration and administration timing on all observed growth and yield variables of shallot plants. LOF concentration treatment did not significantly affect all growth and yield variables of shallot plants. Both concentration treatment and administration timing did not significantly influence all growth and yield variables of shallot plants; however, the best results were observed with administration 3 weeks after planting.

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