Application of bokashi goat manure and organic liquid fertilizer to improve the growth and yield of Lembah Palu shallot variety

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Abstract. The study aims to determine the effect of the application of solid organic fertilizers from bokashi goat manure (BGM) and liquid organic fertilizer (LOF) of cow urine to improve the growth and yield of 'lembah palu' shallot varieties. The study was conducted on farmers' land in Sidera Village Subdistrict Sigibiromaru Sigi Regency in Central Sulawesi. Research using Random Complete Block Design (RCBD) in factorials design (two-factor) with three replications. The first factor is the application of BGM, consists of 2 levels, namely: (1) without BGM and (2) BGM 30 t ha⁻¹; The second factor is the concentration of LOF consists of 3 levels: (1) without the LOF, (2) LOF 16 L ha⁻¹ and (3) LOF 32 L ha⁻¹. The results of the research showed that BGM 30 t ha⁻¹, followed by application of 16 L ha⁻¹ LOF produce shallot crop is higher, and the number of tuber per hill and the fresh weight of tuber per hectare of shallot 'lembah palu' variety is higher compared with a combination of other treatments. BGM 30 t ha⁻¹ produced more leaf number and fresh weight of tubers per plant higher and significantly different without BGM. Application LOF 32 L ha⁻¹ produce of shallot leaves more than without LOF and LOF 16 L ha⁻¹.

1. Introduction
The Lembah Palu variety is one of the superior national varieties of shallots from Central Sulawesi Province, which has been released by the Ministry of Agriculture R.I. [1]. Shallot bulbs are generally used as the main raw material for the fried onion industry in Central Sulawesi. One of the uniqueness of these onions that distinguishes it from other types of shallots is that the tubers have a dense texture, resulting in crispy and savory fried onions and an unchanging aroma, even though they are stored for a long time in a closed container [2].

The 'lembah palu' shallot has been cultivated by farming communities in the Palu Valley region (all areas of Palu City and parts of Sigi and Donggala districts). Shallot, in general (85%), is cultivated on dry land, and only about 15% is cultivated in paddy fields [3]. The productivity of 'lembah palu' shallots is still low, only around 3.5-4.5 tons ha⁻¹ [4] when compared with the potential yield, which can reach 9.7 t ha⁻¹ [1]. This is because of the application of cultivation technology to the 'lembah palu' shallots, which is not yet optimal. The low production of shallots can be caused by the lack of...
absorption of farmers towards new technologies such as the inappropriate use of fertilizers and pests and disease control that are not given enough attention. The use of synthetic chemical fertilizers (agrochemicals) in shallot cultivation is still very high, so that farmers' income is very low, due to higher fertilizer prices. To overcome this, alternative fertilizers using raw materials from local potential natural resources need to be developed.

Shallots of the 'lembah palu' variety require certain environmental conditions to be able to grow and develop properly. The conventional environment of 'lembah palu' shallots variety, which is at locations with altitudes of 10-400 m above sea level (asl.) [1], but with the modification of the microclimate using clear plastic caps and mulch, the 'lembah palu' shallots can adapt to a height of 750 m asl. [5]. In general, shallots are not resistant to drought or waterlogging. If the shallot lack of water, there will be a physiological response or inhibition of metabolic processes through a decrease in the rate of photosynthesis, thereby affecting the growth and yield of tubers, conversely if soil moisture is too high, it will produce low-quality tubers [6]. In particular, 'Lembah palu' shallots require soil moisture that is always at 100% field capacity (FC), even in the lowlands with an average daily temperature of 30°C, soil moisture is required to be higher than 100% FC throughout its growth period, except towards harvest [7].

One way to increase the production of shallots is the application of good farming practices, especially the use of appropriate fertilizers. Fertilization is an effort to increase the supply of nutrients needed by plants to improve the quality and quantity of production. [8] stated that plants are not enough to only rely on nutrients from the soil. Therefore, plants need to be given additional nutrients from the outside through fertilization, both in the form of inorganic fertilizers and organic fertilizers. Based on the type of organic fertilizer, consisting of solid organic fertilizer and liquid organic fertilizer [9]. Organic fertilizer is the fertilizer that consists mostly or entirely of organic material derived from plant residues, and or animals that have undergone engineering in the form of solid or liquid [10]. The use of organic fertilizers is very important in influencing the physical, chemical, and biological characteristics of the soil and influencing organic conditions [11].

[10] states that the use of organic fertilizers is more profitable than inorganic fertilizers because it does not cause residual organic acids in the soil and does not damage the soil if given too much. To be able to grow and produce optimally, plants need essential nutrients, in addition to solar radiation and water. The use of organic fertilizers with the same material continuously will cause nutrient imbalance, so that accumulation of K nutrients and Mg deficiency often occur [12]. Essential nutrients are nutrients that play an important role as sources of nutrients for plants, and their role cannot be replaced by other nutrients. The use of organic fertilizers with a high C/N ratio and not yet mature can cause N deficiency [13].

Liquid organic fertilizer is organic fertilizer derived from various types of materials, including crop residues (straw, stover, corn cobs, sugarcane bagasse, and coconut fiber), sawdust, animal dung, mushroom waste, market waste, household, and factory waste and green manure, and applied by dissolving it with water [14]. Liquid organic fertilizers contain certain substances such as microorganisms that are rarely found in solid organic fertilizers, can also quickly overcome the problem of nutrient deficiency, are not problematic in nutrient leaching, and are able to provide it quickly [9]. The content in liquid organic fertilizer is cow manure, including sixteen nutrients needed by plants.

The addition of organic fertilizer into the soil has a good effect on the development of microorganisms in the soil to remodel organic matter into the elements available to plants. Nutrients in the soil are available in sufficient quantities, absorption of nutrients in sufficient quantities is able to increase the process of photosynthesis quickly which will indirectly affect the increase in growth and yield of shallots [15].

According to [16] fertilization through leaves gives a faster effect on plants than through roots. The rate of nutrient absorption is also influenced by nutrient status in the soil. If the nutrient content in the soil is low, the absorption of nutrients through the leaves is relatively faster. The use of organic fertilizer from chicken manure is 15 tons.ha⁻¹ and added with liquid organic fertilizer 2 cc.L⁻¹ water
can add tillers, increase the weight of fresh tubers, and the weight of dried bulbs of shallots per hectare [17]. Liquid organic fertilizer from cow urine contains macro and micronutrients which are essential nutrient elements that are needed by plants, so it is important to conduct research to test the effect of liquid organic fertilizer from cow urine combined with bokashi goat manure to increase growth and shallots of the 'lembah palu' variety.

2. Methods
The study was conducted on farmers' land in Sidera Village, Sigi Biromaru District, Sigi Regency, Central Sulawesi Province, in May-September 2014. In this study, the 'lembah palu' variety of shallot seeds (bulb) obtained from Soulowe Village as a center of shallot production in Sigi Regency, bokashi goat manure, liquid organic fertilizer (LOF) from cow urine waste, and fungicide (Dithane-M45). The equipment used is a hand tractor, hoe, hand sprayer, sprinkle, hose, plastic pipe, measuring instrument, and writing stationery.

This study used a Complete Randomized Block Design (RCBD). Factorial pattern (2 factors), repeated 3 (three) times. The first factor is the dose of goat manure bokashi (B) consisting of 2 levels, namely; (B0) = without bokashi manure, and (B1) = bokashi goat manure 30 tons.ha\(^{-1}\). The second factor is the concentration of liquid organic fertilizer from cow urine (C), consisting of 3 levels, namely: (C0) without liquid organic fertilizer, (C1) liquid organic fertilizer 16 L.ha\(^{-1}\), and (C2) liquid organic fertilizer liquid waste cattle 32 L.ha\(^{-1}\).

The trial field is perfectly cultivated. The soil was plowed twice with a hand tractor, after which the ground was flattened using a hoe. The plot size of the experiment is length 3m x width 1.2m x height 0.25 m. The application of fertilizer from Bokashi goat manure is made a week before planting. Bokashi goat manure was applied to the experimental plot according to the dose of each treatment, namely: 0 t.ha\(^{-1}\) (without bokashi) and bokashi goat manure with a dose of 30 tons.ha\(^{-1}\) or equivalent to 13.5 kg.plots\(^{-1}\). Application of liquid organic fertilizer (LOF) of cow urine begins when the plant is 15 days after planting (HST) and continues at the age of 25 HST, and 35 HST, according to the concentration of each treatment.

Before planting, shallot seeds are cut 1/3 of the tip to stimulate bud growth to grow evenly. The seeds that have been cut off are immersed in a Dithane-M45 fungicide solution for 10 minutes to free the disease. Shallot seeds are planted in 1 tuber per hole, with a spacing of 15 cm × 15 cm.

Plant maintenance includes irrigation, pest and disease control, and weed control. Watering with a sprinkle irrigation system for 1.0-1.5 hours for every 3 days, except if there is sufficient rain for the water needs of the shallot plant or reach field capacity. Weed control is routinely carried out to prevent the development of weeds at the experimental site controlling weed growth in the experimental plot. Pest and disease control is carried out with the principle of integrated pest control (IPM).

Harvest bulbs of 'lembah palu' varieties are done after the shallot plants show signs of drooping and yellowing leaves, and the bulbs have begun to rise above the soil surface. In this study, shallot bulbs were harvested when the plants were 70 days after planting (DAP).

Observed parameters include plant height and number of leaves measured from 5 (five) plant samples each treatment, observed at the age of 30 DAP, the number of tubers per clump, fresh weight of tubers per clump, and fresh weight of tubers per hectare.

Observational data were analyzed using Analysis of Variance (ANOVA), then to find out the differences between treatments followed by BNJ test α 0.05.

3. Results dan discussion

3.1. Plant height
Shallot of 'lembah palu' varieties at the age of 30 days after planting, produce higher plants at a dose of bokashi manure 30 t.ha\(^{-1}\) plus LOF from cow urine concentration of 16 L.ha\(^{-1}\) (21.47 cm), and significantly different from LOF 16 L.ha\(^{-1}\) concentration and without bokashi manure (Table 1). Table 1 shows that there is no significant difference from the use of LOF in cow urine, in giving bokashi
cow manure 30 t.ha$^{-1}$, conversely, there is no difference in plant height between the treatment without bokashi and bokashi goat manure 30 t.ha$^{-1}$ if given LOF 32 L.ha$^{-1}$. This shows that the bokashi from goat manure significantly affects the height of the onion plant when compared with the LOF from cow urine. Bokashi from cow manure can help improve soil physical properties, especially improve soil structure and improve the ability of the soil to absorb water, and supply nutrients for shallot plants. Giving organic fertilizer into the soil in the form of bokashi compost will directly increase the content of soil organic matter because it has a high content of organic matter.

### Table 1. Plant height (cm) of shallots at the age of 30 DAP at various interaction bokashi doses of goat manure and concentration of liquid organic fertilizer from cow urine

| Bokashi of Goat Manure | Liquid Organic Fertilizer/LOF (C) | Tukey α= 0.05 |
|------------------------|----------------------------------|---------------|
|                        | (C0)                             | (C1)          | (C2)          |
| No bokashi (P0)        | 19.95$^b$                        | 18.48$^a$     | 20.10$^b$     |
| Bokashi 30 t.ha$^{-1}$ (P1) | 20.81$^a$  | 21.47$^a$     | 20.83$^a$     |
| Tukey α 0.05           |                                  |               | 0.67          |

Note: The numbers in the same column (p,q) and row (a,b) followed by the same letter are not significantly different in the Tukey test α 0.05.

According to [18], cow manure given into the soil undergoes decomposition, which ends with mineralization and the formation of humus composed of cellulose, lignin, and protein-containing C-organic which generally increases the C-organic of the soil. Furthermore, [19] states that protein is the main constituent of protoplasm, which functions as a center of metabolic processes in plants, which will further stimulate cell division and elongation and subsequently cause plants to grow taller.

### 3.2. Number of leaves

The application bokashi from goat manure significantly affected the number of leaves of shallot plants at the age of 30 DAP, but the interaction of bokashi manure with LOF from cow urine did not significantly affect the number of shallot leaves. In table 2, it is shown that the application of bokashi manure from goats 30 t.ha$^{-1}$ produces the highest number of leaves of shallot plants (15.59 sheet) and is significantly different from without bokashi (13.76 sheets). This shows that bokashi goat manure as organic fertilizer can stimulate plant growth because organic fertilizer can improve the physical, chemical, and biological properties of the soil. As stated by [20] that applying bokashi manure can increase soil fertility by improving physical, chemical, and biological soil properties.

### Table 2. Number of leaves aged 30 DAP and fresh weight of tubers per clump of shallot ‘lembah palu’ variety with bokashi treatment

| Bokashi of Goat Manure | Number of leaves (sheet) | Fresh weight of tubers (g / plant) |
|------------------------|--------------------------|-----------------------------------|
| No bokashi (P0)        | 13.76 a                  | 60.87 a                           |
| Bokashi 30 t.ha$^{-1}$ (P1) | 15.59 b     | 82.67 b                           |
| Tukey α 0.05           | 0.25                     | 15.23                             |

Note: The numbers in the same column, followed by the same letter are not significantly different in the Tukey test α 0.05.

Table 2 shows that the application of LOF in cow urine with a concentration of 32 L.ha$^{-1}$ produced the highest number of leaves (17.52 sheet) and was significantly different from without LOF and LOF 16 L. ha-1 (Table 3). This is because the elements contained in LOF cow urine are more complex to
support optimal growth. This relates to the statement of [21] that liquid organic fertilizers besides containing nitrogen comprise all proteins, nucleic acids, and chlorophyll, also contain micronutrients including elements of Mn, Zn, Fe, S, B, Ca and Mg, which functions as a catalyst in the process of protein synthesis and chlorophyll formation. Nitrogen and micronutrients function as constituents of chlorophyll, thus increasing the photosynthetic activity and will produce photosynthates that result in the development of leaf meristematic tissue.

Table 3. Number of leaves of shallot 'lembah palu' variety at the age of 30 days after treatment of liquid organic fertilizer

| Liquid Organic Fertilizers (LOFC) | Number of leaves (sheet) | Tukey α=0.05 |
|-----------------------------------|--------------------------|--------------|
| 0 L.ha⁻¹                          | 13.59 a                  | 2.71         |
| 16 L.ha⁻¹                         | 15.51 a                  |              |
| 32 L.ha⁻¹                         | 17.52 b                  |              |

Note: The numbers in the same column, followed by the same letter are not significantly different in the Tukey test α 0.05.

3.3. Number of tubers per clump

The application of bokashi manure and LOF has a significant effect on the number of tubers of the shallot 'lembah palu' variety. In table 4, it is shown that the 30 t.ha⁻¹ of bokashi manure added with 16 L.ha⁻¹ LOF produced the highest number of tubers, whereas in the treatment without bokashi and without LOF, it produced the least amount of shallot tubers (8.44 tubers.clumps⁻¹).

Table 4. Number of tubers per clump of 'lembah palu' shallot variety on bokashi manure and liquid organic fertilizer treatment

| Bokashi of Goat Manure | Liquid Organic Fertilizers/LOF (C) | Tukey α = 0.05 |
|------------------------|-----------------------------------|---------------|
|                        | No LOF (C0)                       |               |
|                        | LOF 16 L.ha⁻¹ (C1)                |               |
|                        | LOF 32 L.ha⁻¹ (C2)                |               |
| No bokashi (P0)        | q8.44ᵃ                           | p10.83ᵇ       |
| Bokashi 30 t.ha⁻¹ (P1) | q11.67ᵃ                          | q13.00ᵇ       |

Note: The numbers in the same column (p,q) and row (a,b) followed by the same letter are not significantly different in the Tukey test α 0.05.

This shows that the application of goat manure bokashi can increase tuber yield of onion plants because the application of bokashi manure can add organic materials needed by plants. This is consistent with the statement [22] that shallot plants can grow and produce optimally on land with a high content of organic matter, as well as good aerase and draenase.

3.4. Fresh weight of tubers per plant

The interaction of bokashi goat manure with LOF and single factor LOF did not significantly affect the fresh weight of tubers per plant, but the bokashi goat manure significantly affected the fresh weight of tubers per plant ‘lembah palu’ shallot variety. Application of bokashi goat manure 30 t.ha⁻¹ gives a higher fresh tuber weight per plant than without bokashi goat manure (table 2). The application of liquid organic fertilizer on shallots will accelerate the synthesis of amino acids and proteins, thereby accelerating plant growth. This is consistent with the opinion of [23] and [19] that liquid organic fertilizer contains potassium which plays an important role in every process of plant metabolism, namely in the synthesis of amino acids and proteins from ammonium ions and plays a role in
maintaining turgor pressure properly thus allowing smooth metabolic processes and ensuring continued cell lengthening and enlargement.

3.5. Fresh tuber weight per hectare

The interaction of bokashi manure and LOF treatment significantly affected the fresh weight of shallot tubers per hectare. Application of bokashi goat manure 30 t.ha\(^{-1}\) added with liquid organic fertilizer 16 L.ha\(^{-1}\) produces fresh tubers of shallots higher per hectare (7.30 t.ha\(^{-1}\)), whereas the lowest fresh weight of tubers per hectare is obtained (6.04 t.ha\(^{-1}\)) in the treatment without bokashi goat manure and without LOF (Table 5). Application of LOF 32 L.ha\(^{-1}\) concentration, whether followed by delivery of bokashi cow manure or without bokashi, can reduce the weight of fresh tubers per hectare. This can occur because the shallot plants have experienced nutrient saturation so that the nutrients provided are no longer effectively absorbed by the plants. As [24] stated that the application of LOF in higher concentrations would cause a decrease in plant height, a number of leaves, leaf area index, and fresh weight of plants due to the increase of nutrients available in the soil and leaves, resulting in excess of nutrients for plants and this will disrupt the balance of nutrients absorbed, so that it will suppress the growth and development of plants. Conversely, the application of POC in optimal concentrations, according to plant nutrient requirements, will produce a maximum growth and tuber formation. This is caused by nutrients nitrogen, phosphorus, and potassium as well as microelements contained in liquid organic fertilizer, which serves to increase the photosynthetic activity of onion plants and produce more carbohydrates as food reserves stored in the tubers as organs for storing photosynthetic products. [21] states that the increase in tuber biomass is influenced by the amount of water absorption and the accumulation of photosynthesis results. Furthermore, [19] states that the macro and micronutrients contained in liquid organic fertilizer produce a complex effect on the formation and production of carbohydrates, and the phosphorus nutrient is the constituent of ATP needed to reduce CO to a solid organic compound so that it will produce tuber biomass.

| Bokashi of Goat Manure | Liquid Organic Fertilizer/LOF (C) | Tukey α= 0.05 |
|------------------------|---------------------------------|--------------|
|                        | No LOF (C0)                      |              |
|                        | LOF 16 L.ha\(^{-1}\) (C1)        |              |
|                        | LOF 32 L.ha\(^{-1}\) (C2)        |              |
| No bokashi (P0)        | p6.04\(^{a}\)                   | p6.82\(^{b}\) |
| Bokashi 30 t.ha\(^{-1}\) (P1) | q7.15\(^{b}\)                  | p7.30\(^{b}\) |

Tukey α= 0.05 0.62

Note: The numbers in the same column (p,q) and row (a,b) followed by the same letter are not significantly different in the Tukey test α 0.05.

4. Conclusion

The results of the research showed that (1) bokashi goat manure 30 t.ha\(^{-1}\), followed by application of 16 L.ha\(^{-1}\) LOF urine of cows produce shallot crop is higher, and the number of tuber per hill and the fresh weight of tuber per hectare of shallot 'lembah palu' variety is higher compared with a combination of other treatments. (2) Bokashi application of goat manure 30 t.ha\(^{-1}\) produced more leaf number and fresh weight of tubers per plant higher and significantly different without bokashi. (3) Application LOF 32 L.ha\(^{-1}\) produce of shallot leaves more than without LOF and LOF 16 L.ha\(^{-1}\).

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