AGRONOMIC PERFORMANCE OF SHALLOT (*Allium cepa* L. var. *Aggregatum*) UNDER DIFFERENT MULCH AND ORGANIC FERTILIZERS†

[COMPORTAMIENTO AGRONÓMICO DE LA CHALOTA (*Allium cepa* L. var. *Aggregatum*) BAJO DIFERENTES ABONOS ORGÁNICOS Y ACOLCHADOS]

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SUMMARY

Background. Shallot plant is an important commodity in Central Sulawesi because it functions as a raw material in the fried onion home-industry. **Objective.** The aim of this study was to evaluate the effect of mulch and organic fertilizers on the agronomic performance of the "Lembah Palu" variety of shallot (*Allium cepa* L. var. *Aggregatum*) on dryland. **Methodology.** The experiment consisted of three types of mulch (no mulching, rice straw, and *Gliricidia sepium* leaf) and four types of organic fertilizers (no fertilizer, bioculture, biourin and cattle manure compost). The experiment was laid out as a randomized complete block design in a factorial arrangement with three replications. A total of 36 plots were used for the experiment. The agronomic performance measured were: plant height, number of leaves per plant, number of tillers, fresh weight, dry weight, bulb diameter and bulb yield of shallot. Environmental parameters include temperature and humidity. **Result.** Results showed that the application of rice straw mulch plus bioculture organic fertilizer had positive significant effect ($P \leq 0.05$, respectively) on next agronomic parameters: plant height, number of leaves per plant, number of tillers, fresh weight, dry weight, bulb diameter and yield bulb of shallot. **Implications.** Significantly positive results on the agronomic parameters of shallots indicate that the application of mulch and bioculture organic fertilizers can be used on other crops to increasing the efficiency of dryland. **Conclusion.** The highest production of shallots was 9.46 t$\cdot$ha^{-1}. Thus, it can be recommended that straw mulch at a dose of 5 t$\cdot$ha^{-1} and bioculture at a dose of 750 L$\cdot$ha^{-1} is better for the growth and yield of shallot in dryland. The use of rice straw mulch and bioculture as organic liquid fertilizer provides benefits to increase productivity, add value to the crop and livestock waste, reduce environmental pollution, and application to plants will produce healthy products.

Key words: Cattle manure; *Gliricidia sepium*; compost; growth and yield; straw mulch.

RESUMEN

Antecedentes. La planta de chalota es un producto importante en el centro de Sulawesi porque funciona como materia prima en la industria casera de la cebolla frita. **Objetivo**. El objetivo de este estudio fue evaluar el efecto del mantillo y fertilizantes orgánicos sobre el comportamiento agronómico de la variedad de chalote "Lembah Palu" (*Allium cepa L. var. Aggregatum*) en secano. **Metodología.** El experimento consistió en el uso de tres tipos de mantillo (sin mantillo, paja de arroz y hoja de *Gliricidia sepium*) así como cuatro tipos de fertilizantes orgánicos (sin fertilizante, biocultivo, biourina y abono de estiércol de ganado). El experimento se presentó como un diseño de bloques completos al azar en un arreglo factorial con tres repeticiones. Se utilizó un total de 36 parcelas para el experimento. Las variables agronómicas evaluadas fueron: altura de planta, número de hojas por planta, número de macollos, peso fresco, peso seco, diámetro de bulbo y rendimiento de bulbo de chalota. Los parámetros ambientales incluyeron temperatura y humedad. **Resultados**. Los resultados mostraron que la aplicación de mantillo de paja de arroz con fertilizante orgánico de biocultivo tuvo un efecto positivo significativo ($P \leq 0.05$, respectivamente) en los siguientes parámetros agronómicos como aumento de altura de planta, número de hojas por planta, número de macollos, peso fresco, peso

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seco, diámetro del bulbo y rendimiento del bulbo de la chalota. **Implicaciones.** Resultados significativamente positivos en parámetros agronómicos de chalota indican que la aplicación de fertilizantes orgánicos oriundos de biocultivos pueden ser utilizada en otros cultivos para aumentar la eficiencia en sequías. **Conclusión**. La mayor producción de chalotes fue de 9.46 t·ha^{-1}. Por lo tanto, se puede recomendar que el mantillo de paja a una dosis de 5 t·ha^{-1} y el biocultivo a una dosis de 750 L·ha^{-1} sea mejor para el crecimiento y rendimiento de la chalota en secano. El uso de mantillo de paja de arroz y el biocultivo como fertilizante líquido orgánico proporciona beneficios para aumentar la productividad, agregar valor a los desechos de cultivos y ganado, reducir la contaminación ambiental y la aplicación a las plantas producirá productos saludables.

Palabras clave: Estiércol de ganado; *Gliricidia sepium*; compost; crecimiento y rendimiento; mantillo de paja.

INTRODUCTION

Shallot plant is an important commodity in Central Sulawesi because they it is used as a raw material in the fried onion home-industry. One type of shallot that is popular by farmers is the 'Lembah Palu' variety of shallot (*Allium cepa* L. var. *Aggregatum*). The results of the Lembah Palu variety of shallot survey show that the weight of a clump of shallot is an average of 12.5 grams with a total of five cloves of bulbs. With a population of 266,000 plants per hectare, it will produce 3.3 tonnes. The production of shallot is still very low when compared to the potential yield of 10–12 t·ha^{-1} (Central Bureau of Statistics Central Sulawesi, 2016). The low production is due to the shallot plant being planted in dryland.

Dryland has limitations, especially water availability, nutrient retention, and low organic matter content. In order to overcome these obstacles, dryland cultivation technology is needed, such as the application of mulch and organic fertilizers. Mulch can be in the form of plant debris, ground cover crops, rice straw, grasses, wood chips and other materials classified as organic mulch, as well as synthetic materials in the form of polyethylene plastic, aluminum foil, gravel, the paper which are classified as mulch non-organic.

Mulch plays a role in lowering soil temperature while maintaining soil moisture (Adekiya, 2018). Organic mulch improves soil nutrients, maintains optimal soil temperature, reduces the rate of evaporation from the soil surface, and prevents soil erosion (Ranjan *et al.*, 2017). Also, mulch reduces weed growth so a lower weed prevalence significantly increases the efficiency of water use (Mutetwa and Mtaita, 2014).

Organic fertilizers are composed of living matter such as the weathering of the remains of plants and animals. Sources of organic material can be compost, green manure, manure, crop residues, livestock waste, industrial waste using agricultural materials and organic waste. Organic fertilizers can be solid or liquid which are used to increase vegetative growth (Kandil *et al*., 2013) and yields (Idham *et al*., 2021; Petrovic *et al*., 2020). Also, it plays a role in providing nutrients to the soil by improving the physical, chemical and biological properties of the soil (Müjdeci *et al*., 2020) and the efficiency of using fertilizers (Yang *et al*., 2020).

Cattle manure compost as organic fertilizer is made from cow dung and straw fermented with decomposing microorganisms. Cattle manure compost has been widely used by farmers as an alternative to chemical fertilizers because it contains macro-nutrients such as N, P, K and micro-nutrients such as Ca, Mg and Zn (Perdana *et al*., 2015).

Cow urine and manure contain macronutrients and micronutrients that can be used as a source of organic fertilizer (Gómez-Muñoz *et al*., 2017). Cow urine contains nitrogen, sulfur, phosphate, potassium, sodium, manganese, carbolic acid, iron, silicon, chlorine, salt, enzymes and hormones (Choudhary *et al*., 2017). It also contains 95% water, 2.5% urea and the remaining 2.5% is a mixture of salts, hormones, enzymes and minerals (Pradhan *et al.*, 2018).

Cow urine and feces can be made into liquid organic fertilizer by the anaerobic fermentation process. Organic fertilizer products from cow urine are known as biourine while cow urine and feces are known as bioculture (Lasmini *et al*., 2020). Apart from being an organic fertilizer, cow urine can act as a biopesticide and anti-fungal (Gottimukkala *et al*., 2019).

Many studies have shown the positive effects of organic fertilizers, especially cattle manure compost (Adeyeye *et al*., 2017; Cevheri and Yilmaz, 2018; Eifediyi *et al*., 2022) and also the positive effect of organic mulch on the growth and yield of shallot (Lasmini *et al.*, 2019), but there is still lack of information about the combination of organic mulch and organic liquid fertilizers on the growth and yield of shallot. Thus, this study aims to evaluate the agronomic performance of the Lembah Palu variety of shallot (*A. cepa* L. var. *Aggregatum)* which are applied with organic mulch and organic fertilizers in dryland.

MATERIALS AND METHODS

Experimental site and meteorological conditions

The research was carried out in Bulupountu Jaya Village, Sigi Biromaru District, Sigi Regency, Central

Sulawesi Province Indonesia. It was performed from February to October 2017, at an altitude of 120 m above sea level. It is located at 1°0.37"S latitude and 119°56"E longitude. Soil is of inceptisol type, and climate is characterized by air temperature around 32.4 °C, and annual average air humidity of 63%.

Experimental design

The study used a combination of three types of mulch (no mulch, straw, and *Gliricidia sepium* leaf mulch) and four types of organic fertilizers (no fertilizer, bioculture, biourine and cattle manure compost). Treatments were arranged in randomized complete block design. Each treatment was replicated three times to obtain 36 experimental units.

Bioculture preparation

The preparation of bioculture liquid organic fertilizer refers to Lasmini (2020), as follows: (i). Five liters of cow urine and five kg of cow feces are put into the bucket. (ii). Added 50 liters of water. (iii). Stirred into a solution. (iv). The solution was added with 50 mL of microbial decomposition (EM4) and 70 cc of fe-challate and extracts of galangal (*Alpinia galanga* (L.) Wild., turmeric (*Curcuma longa* L.) and kencur (*Kaempferia galanga* L.) each one ounce and citronella grass (*Cymbopogon nardus* (L.) Rendle. extract fragrant 10 sticks (v). Stir until all ingredients become homogeneous. (vi). Stirring lasts for three weeks so that the ammonia which is toxic to plants evaporates. (vii). The finished solution is ready to be applied to shallot plants

Biourine preparation

Preparation of biourin liquid organic fertilizer, as follows: (i) 500 L of cow urine is put into the bucket. (ii) added with 100 mL of microbial decomposition (EM4) and 70 cc of fe-challate. (iii) Stir until all the ingredients are homogeneous. (vi) Stirring lasts for three weeks so that the ammonia which is toxic to plants evaporates. (vii) The finished solution is ready to be applied to shallot plants.

Crop establishment and agronomic practices

The research was started by cultivating the land, namely plowing it once and harrowing it twice so that the soil was destroyed properly. After that, the beds were made 1.20 m x 4.0 m north and south. The distance between the replication plots was 60 cm and the treatment plots were 40 cm with a depth of 40 cm which functioned as a drainage channel.

Shallot seeds before planting cut a third part at the end. The spacing of shallots is 15 cm x 20 cm and each hole is planted one shallot seed bulb sterilized with a fungicide solution. The shallot seeds used are Lembah Palu variety (*A. cepa* L. var. *Aggregatum*). The application of rice straw mulch and *G. sepium* leaf mulch was carried out seven days after planting with a dose of five $t{\cdot}ha^{-1}$ each, while the application of organic fertilizer was carried out seven days before planting. Bioculture and biourine were poured evenly on the soil surface at a dose of 750 $L{\cdot}ha^{-1}$, while the cow dung compost was evenly dispersed at a dose of five $t{\cdot}ha^{-1.}$ Maintenance of plants by watering, weeding and controlling pests and diseases.

Data collection

Data were collected at seven-day-intervals starting from 7 to 49 days after planting. The agronomic variable measured were: plant height, number of leaves, number of tillers, fresh weight, dry weight, and bulb diameter of shallot. The number of samples for each observation variable was 10 clumps of shallot plants. Plant height was measured using the meter ruler from the base of plant to the tip of the leaf. The number of leaves was obtained by visual counting of the leaves. The diameter of the bulb was measured by a caliper, fresh weight and dry weight were measured by digital scales. The bulb yield per hectare is determined by converting the fresh weight of the bulb into tonnes per hectare. Environmental parameters include temperature and humidity.

Statistical analysis

The data collected were analyzed statistically using analysis of variance or the F test at the 5% level. To compare the average between treatments used HSD at the 5% level. The variable is normally distributed if the significance value is more than or equal to 0.05, otherwise if it is less than 0.05 then the variable or data is declared not normally distributed.

RESULTS

Plant height

Table 1 shows the effect of mulch treatment and organic fertilizers on the height of shallot plants. Mulch treatment was significantly different on plant height except for 2 weeks after transplanting (WAT). Application of rice straw mulch showed the highest shallot plant height in all sampling periods and was different from *G. sepium* leaf mulch and no mulching. *G. sepium* leaf mulch treatment was not statistically different from the no mulching except in the 4 WAT period. In the type of organic fertilizer, bioculture gave the highest plant height in all sampling periods and was

Table 1. Effect of mulches and organic fertilizer on plant height (cm) of shallot.

Treatment[x]	Sampling period (WAT)[y]					
	2	**3**	**4**	**5**	**6**	**7**
M0	6.26 ± 1.27 a[z]	18.64 ± 0.59 b	21.16 ± 1.02 c	23.55 ± 1.01 b	24.00 ± 1.25 b	24.36 ± 1.00 b
M1	6.73 ± 0.90 a	21.13 ± 0.81 a	24.63 ± 0.69 a	26.40 ± 1.20 a	26.56 ± 1.16 a	26.68 ± 1.14 a
M2	6.32 ± 1.13 a	19.14 ± 0.73 b	22.90 ± 1.19 b	24.02 ± 1.10 b	24.52 ± 1.03 b	24.85 ± 1.09 b
HSD 5%	**0.47**	**1.20**	**0.70**	**1.28**	**0.78**	**0.83**
O0	4.82 ± 0.52 b	18.92 ± 1.2 b	21.68 ± 2.07 c	23.46 ± 1.36 b	23.70 ± 1.39 c	24.07 ± 1.20 c
O1	7.24 ± 0.09 a	20.49 ± 1.4 a	24.01 ± 1.67 a	26.09 ± 1.60 a	26.33 ± 1.48 a	26.55 ± 1.42 a
O2	6.97 ± 0.31 a	19.62 ± 1.6 a	23.07 ± 1.64 b	24.63 ± 1.74 b	25.21 ± 1.39 b	25.41 ± 1.40 b
O3	6.72 ± 0.22 a	19.52 ± 1.0 a	22.85 ± 1.60 b	24.44 ± 1.46 b	24.85 ± 1.38 b	25.17 ± 1.06 b
HSD 5%	**0.55**	**1.39**	**0.81**	**1.48**	**0.90**	**0.96**
O	ns	ns	ns	ns	ns	ns

Note: [x]M0: no mulching, M1: rice straw mulch, M2: *Gliricidia. sepium* leaf mulch, O0: no fertilizer, O1: bioculture organic fertilizer, O2: biourine organic fertilizer, O3: cattle manure compost. HSD = honestly significant difference. [y]WAT= week after transplanting, [z]Value are presented as means (n=3). ns: non-significant, ± : estimate standard error. Different letters in the same column indicate significant difference according to Tukey's test ($P \leq 0.05$).

different from all treatments except at 2 WAT and 3 WAT which were the same as biourine and cattle manure compost.

Number of leaves per plant

Results showed that the application of mulch had a significant effect on the number of leaves per plant of shallots in all sampling periods. Rice straw mulch had the highest number of leaves per plant and was different from *G. sepium* leaf mulch and no mulching, except in the 2 WAT period which was the same as *G. sepium* leaf mulch (Table 2). Application of bioculture gave the highest number of leaves per plant and was different from other treatments at 2 WAT, 3 WAT, and 4 WAT, while in the 5 WAT, 6 WAT, and 7 WAT period, it was different from no fertilizer but the same as biourine and cattle manure compost.

Number of tiller per clump

The application of straw mulch significantly increased the number of tiller per clump at all observation periods, which was statistically different from *G. sepium* leaf mulch and control, except for 4 WAT which was not statistically different from *G. sepium* leaf mulch (Table 3). The application of organic fertilizers affected all observation periods except for 4 WAT which had no significant effect. Bioculture application was statistically different from other treatments but biourine application was not different with cattle manure compost.

Fresh and dry weight

The application of straw mulch significantly increased the wet weight and dry weight of shallot plants, which differed statistically from *G. sepium* leaf mulch and control, but the dry weight was not statistically different from *G. sepium* leaf mulch (Table 4). The application of organic fertilizers statistically affected the fresh weight and dry weight of shallot plants. Bioculture application was significantly different from other treatments. On the dry weight of shallot plants, the application of biourine was significantly different from the no fertilizer but not significantly different from cattle manure compost.

Bulb diameter

The bulb diameter of shallot increased in the application of mulch and organic fertilizers and had a statistically significant effect. The straw application was different from all treatments except *G. sepium* leaf mulch which was not significantly different (Table 4). The application of organic fertilizers had a statistically significant effect on the bulb diameter of shallot.

Bioculture application was statistically different from other treatments, but the application of biourine was not significantly different from cattle manure compost.

Bulb yield

The bulb yield of shallot increased in the application of mulch and organic fertilizers and had a statistically significant effect. The straw application was different from all treatments except *G. sepium* leaf mulch which was not significantly different (Table 4). The application of organic fertilizer has a statistically significant effect on the yield of shallot bulbs. Bioculture was statistically different from cattle manure compost, but not significantly different from biourine.

Table 2. Effect of mulches and organic fertilizer on leaf number per plant (leaves) of shallot.

Treatment^{x}	**Sampling period (WAT)**^{y}					
	2	**3**	**4**	**5**	**6**	**7**
M0	7.28 ± 1.94 b^{z}	14.21 ± 0.85 c	18.13 ± 1.08 c	19.66 ±1.19 c	19.86 ± 1.33 c	20.16 ± 1.12 c
M1	8.03 ± 1.97a	17.50 ± 1.02 a	23.20 ± 0.96 a	25.77 ±1.39 a	26.11 ± 1.53 a	26.63 ± 1.94 a
M2	7.80 ± 2.33 ab	16.08 ± 0.88 b	20.03 ± 1.13 b	22.07 ±1.06 b	22.63 ± 0.91 b	22.96 ± 0.79 b
HSD 5%	**0.59**	**0.64**	**1.51**	**2.30**	**1.96**	**2. 03**
O0	4.69 ± 0.46 c	15.08 ± 1.50 c	19.98 ± 2.31 b	21.12 ±2.81 b	21.43 ± 2.81 b	21.68 ± 2.67 b
O1	9.37 ± 0.67 a	17.11 ± 1.82 a	21.97 ± 2.48 a	23.90 ±2.87 a	24.37 ± 3.06 a	24.78 ± 3.71 a
O2	8.51 ± 0.26 b	16.04 ± 1.24 b	20.08 ± 2.79 b	22.80 ± 3.64 ab	23.01 ± 3.49 ab	23.36 ± 3.44 ab
O3	8.23 ± 0.32 b	15.56 ± 1.97 b	19.78 ± 2.72 b	22.17 ± 3.00 ab	22.62 ± 3.27 ab	23.17 ± 3.25 ab
HSD 5%	**0.68**	**0.74**	**17.487**	**2.65**	**2.27**	**2.35**
M×O	ns	ns	ns	ns	ns	ns

Note: ^{x}M0: no mulching, M1: rice straw mulch, M2: *Gliricidia. sepium* leaf mulch, O0: no fertilizer, O1: bioculture organic fertilizer, O2: biourine organic fertilizer, O3: cattle manure compost. HSD = honestly significant difference. ^{y}WAT= week after transplanting, ^{z}Value are presented as means (n=3). ns: non-significant, ± : estimate standard error. Different letters in the same column indicate significant difference according to Tukey's test ($P \leq 0.05$).

Table 3. Effect of mulch and organic fertilizers on tiller number per clumps of shallot.

Treatment^{x}	**Sampling period (WAT)**^{y}			
	4	**5**	**6**	**7**
M0	4.51 ± 0.20 b^{z}	4.54 ± 0.38 c	4.54 ± 0.36 c	4.54 ± 0.38 c
M1	5.57 ± 0.26 a	5.69 ± 0.41 a	5.79 ± 0.33 a	5.60 ± 0.47 a
M2	5.33 ± 0.35 a	5.34 ± 0.43 b	5.32 ± 0.39 b	5.34 ± 0.43 b
HSD 5%	**0.44**	**0.26**	**0.25**	**0.25**
O0	5.07 ± 077 a	4.76 ± 0.61 c	4.88 ± 0.62 c	4.72 ± 0.56 c
O1	5.52 ± 0.69 a	5.71 ± 0.65 a	5.68 ± 0.64 a	5.71 ± 0.65 a
O2	5.06 ± 0.41 a	5.11 ± 0.45 b	5.18 ± 0.52 b	5.07 ± 0.39 b
O3	5.08 ± 0.61 a	5.19 ± 0.66 b	5.13 ± 0.79 b	5.14 ± 0.62 b
HSD 5%	**0.51**	**0.30**	**0.30**	**0.29**
M×O	ns	ns	ns	ns

Note: ^{x}M0: no mulching, M1: rice straw mulch, M2: *Gliricidia. sepium* leaf mulch, O0: no fertilizer, O1: bioculture organic fertilizer, O2: biourine organic fertilizer, O3: cattle manure compost. HSD = honestly significant difference. ^{y}WAT= week after transplanting, ^{z}Value are presented as means (n=3). ns: non-significant, ± : estimate standard error. Different letters in the same column indicate significant difference according to Tukey's test ($P \leq 0.05$).

Table 4. Effect of mulch and organic fertilizers on fresh weight (g), dry weight (g), bulb diameter (mm), and bulb yield ($t \cdot ha^{-1}$) of shallot.

Treatment^{x}	**fresh weight (g)**	**dry weight (g)**	**bulb diameter (mm)**	**bulb yield ($t \cdot ha^{-1}$)**
M0	44.66 ± 4.10 c^{y}	38.10 ± 3.42 b	13.95 ± 1.93 b	8.55 ± 0.73 b
M1	49.29 ± 5.63 a	41.57 ± 2.77 a	15.11 ± 1.95 a	9.46 ± 0.45 a
M2	46.69 ± 5.83 b	39.76 ± 3.18 a	14.74 ± 2.53 a	9.12 ± 0.37 a
HSD 5%	**1.25**	**1.84**	**0.65**	**0.47**
O0	40.38 ± 0.80 d	36.01 ± 2.45 c	11.99 ± 1.10 c	8.43 ± 0.53 c
O1	52.52 ± 2.64 a	43.46 ± 1.44 a	17.08 ± 0.86 a	9.38 ± 0.08 a
O2	48.63 ± 2.67 b	40.47 ± 2.17 b	14.81 ± 0.70 b	9.36 ± 0.55 a
O3	46.00 ± 3.70 c	39.30 ± 0.88 b	14.53 ± 0.50 b	8.99 ± 0.82 b
HSD 5%	**1.44**	**2.12**	**0.75**	**0.55**
M×O	ns	ns	ns	ns

Note: ^{x}M0: no mulching, M1: rice straw mulch, M2: *Gliricidia. sepium* leaf mulch, O0: no fertilizer, O1: bioculture organic fertilizer, O2: biourine organic fertilizer, O3: cattle manure compost. HSD = honestly significant difference. ^{y}Value are presented as means (n=3). ns: non-significant, ± : estimate standard error.
Different letters in the same column indicate significant difference according to Tukey's test ($P \leq 0.05$).

DISCUSSION

Effect of organic mulch on plant growth and yield

Application of mulch in dryland aims to reduce the rate of evaporation and suppress transpiration as well as reduce nutrient leaching. Meanwhile, the application of organic fertilizers aims to provide the nutrients needed for plant growth. Previous studies have reported that rice straw mulch reduces temperatures from 36 °C to 30 °C and increases soil moisture from 35% to 37% in the dryland of the Palu Valley (Lasmini *et al.*, 2019). In this study, the average daily temperature was recorded at 32.4 °C with an average daily humidity of 63%.

The results of the research (Table 1–4) showed that the treatment of organic mulch and organic fertilizer has a significant effect on all observed variables, but there is no interaction effect between the two treatments. The results of further tests with the HSD 5% test showed that the single effect of mulch had a significant effect on plant height, number of leaves per plant, number of tillers per clump, bulb diameter, fresh weight, dry weight and bulb yield of shallot. The single effect of organic fertilizer also had a significant effect on plant height, number of leaves per plant, number of tillers per clump, bulb diameter, fresh weight, dry weight and bulb yield of shallot.

In this study, the application of organic mulch such as rice straw mulch and *G. sepium* leaf mulch increased the growth and yield of shallot compared to no mulching. These results are also by Ahmmed *et al.* (2017) and Lasmini *et al*. (2021). The effect of straw mulch is better than *G. sepium* leaf mulch in increasing plant growth and yield because straw mulch can modify the soil temperature to be cooler so that roots grow faster (Kader *et al.*, 2017). Lower soil temperatures make nutrients more easily available to plants so that the resulting biomass increases. (Iriany *et al*., 2018) stated that the application of mulch can reduce evaporation so that soil moisture increases and in turn will affect the yield and quality of shallot.

Mulch can store and provide water for plants, especially in limited water conditions, so that water use is more efficient. Besides, mulch can maintain soil moisture stability by reducing water loss from the soil surface and the atmosphere. (Kader *et al*., 2017) reported that the use of various types of mulch showed the ability of straw mulch to increase yield compared to silver black plastic mulch. Furthermore, the application of 3 $t \cdot ha^{-1}$ rice straw mulch and 60 $kg \cdot N \cdot ha^{-1}$ can reduce the use of inorganic fertilizers and compensate for the loss of carbon from the decomposition of organic matter (Dossou-Yovo *et al.*, 2016).

Straw mulch that has been decomposed in the soil contains macro and micro-nutrients, namely N (0.4%), P (0.2%), K (0.7%), Si (7.9%) and C (40%). These macro and micro-nutrients are needed by shallot plants to increase growth and yield. Nitrogen increases plant height, the number of leaves and the number of tillers because it is one of the macro elements needed by plants as the main building block for protein for growth (Leghari *et al.*, 2016). The element phosphorus contributes to balance dry matter accumulation (Balemi and Negisho, 2012). The nutrients potassium (K) has an important role as an activator of dozens of important enzymes, such as protein synthesis, sugar transport, N and C metabolism and photosynthesis. It plays an important role in yield formation and quality improvement (Oosterhuis *et al*., 2014); K is also very important for cell growth, which is an important process for plant function and development (Xu *et al*., 2020).

Effect of organic fertilizers on plant growth and yield

The results showed that the treatment of organic fertilizers (bioculture, biourine, and cattle manure compost) had a significant effect on the growth and yield of shallot compared to no fertilizers. With this variation of organic fertilizers, bioculture liquid organic fertilizer is better than biourine liquid organic fertilizer and cattle manure compost (Tables 1–4).

The growth and yield of plants were higher in bioculture applications compared to biourine, cattle manure compost and no fertilizer, this is because bioculture is the result of anaerobic fermentation from fresh cow urine and feces with additional nutrients using other decomposer microbes (Phong and Quynh, 2018). Bioculture contains nutrients N, P, K and other organic materials (Choudhary *et al.*, 2017). N, P and K nutrients are macronutrients that have many functions in plant growth. Nitrogen is one of the constituent elements of chlorophyll which is the absorbent of sunlight in the photosynthesis process. If the N uptake increases, the chlorophyll content also increases so that the photosynthate produced and allocated to plant growth organs also increases (Kume *et al*., 2019).

Bioculture also contain beneficial microbes for plants and auxin hormone butyric acid indole-3 (IBA). According to (Fattorini *et al*., 2017) IBA hormone can stimulate plant roots, affect cell expansion, cell wall plasticity and cell division so that it affects plant vegetative growth. Without bioculture fertilizers, plants only use nutrients and auxins found in the growing media, causing the growth components of shallot plants to have the lowest plant growth compared to those applied to bioculture. The activities of various microorganisms contained in livestock manure that produce growth hormones, such as auxins, gibberellins and cytokines can stimulate plant vegetative growth so that the foraging area is wider. This is as reported by (Rastogi *et al*., 2013) that auxin growth hormone at a dose of 1.0 mg·L^{-1} and gibberellic acid at a dose of 200 mg·L^{-1} increased the vegetative growth of linseed (*Linum usitatissimum* L.).

The yield of shallot plants in bioculture applications (Table 4) resulted in the largest fresh weight, dry weight and bulb yield of shallot compared without fertilizer, this is because bioculture has various advantages, such as higher nutrient content than manure. Its application to plants is easier and does not cause odor, besides bioculture is a liquid so that it is easily absorbed by plants and can absorb water. The absorption of water by plants will help the absorption of nutrients so that it has an impact on the vegetative development of plants which will also increase plant weight (Khusanbayevich *et al*., 2020).

The application of bioculture and biourine in addition to improving soil texture and functioning as plant hormones are also reported to improve micronutrient deficiencies because they are organic and tend to increase the efficiency of fertilizer use (Yang *et al.*, 2020). The use of organic fertilizers is an effective technique for improving physical properties associated with increasing soil organic matter which leads to soil quality (Müjdeci *et al*., 2020; Tabaxi *et al*., 2020), and re-use animal manure, conferring them an added value (Martínez-Alcántara *et al*., 2016; Zainudin *et al.*, 2022). Hopefully, the use of bioculture and biourine organic fertilizers can increase sustainable agricultural production because as it is known to be environmentally friendly, economically feasible and easily obtained in abundance.

CONCLUSIONS

The application of rice straw mulch and bioculture liquid organic fertilizer to the Lembah Palu variety of shallot (*Allium cepa* L. var. *Aggregatum*) on dryland had a significant effect on agronomic parameters such as plant height, number of leaves per plant, number of tillers per clump, fresh weight, dry weight, bulb diameter, and yield of shallot. The highest production of shallots was 9.46 t·ha^{-1} was significantly different compared to other treatments. Thus, it can be recommended that straw mulch at a dose of 5 t·ha^{-1} and bioculture at a dose of 750 L·ha^{-1} is better for the growth and yield of shallot in dryland. The use of use of rice straw mulch and bioculture as organic liquid fertilizer provides benefits to increase productivity, add value to the crop and livestock waste, reduce environmental pollution, and application to plants will produce healthy products.

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