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Increased Growth and Production of Shallots (Allium ascalonicum L.) with Mulching Type treatment and Tuber Weight

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Abstract: This study aims to determine the effect of mulch type and bulb weight on the growth and yield of onion production (Allium ascalonicum L.). In detail, this study aims to (1). Know the type of mulch that is most suitable for the growth and production of onion plants. (2). Knowing the weight of bulbs is best for the growth and production of onion plants. (3). Know the interaction between the type of mulch and the weight of bulbs used for the growth and production of onion plants. This study used Group Randomized Design (RAK) with 2 treatments, namely Factor I: three types of Mulch use (M): M0 = No Mulch; M1= Silver black plastic mulch (0.35 cm thick); M2= Mulch rice straw (1.5 cm thick). Factor II: three tuber weight intervals, namely: B0= 0 - 1.4 g (Small Tuber); B1= 1.5 – 1.8 g (Medium Tuber); B2 = > 1.8 g (Large Tubers). The results showed that the treatment of several types of mulch had a significant effect on plant height, weight of fresh tubers per clump, number of fresh tubers per clump, weight of fresh tubers per plot and number of fresh tubers per plot. M1 silver black plastic mulch treatment resulted in the highest plant height, weight of fresh tubers per clump (148.22 g), number of fresh tubers per clump, weight of fresh tubers per plot. Tuber weight treatment has a noticeable effect on plant height, number of leaves, weight of fresh tubers per clump, number of fresh tubers per clump, weight of fresh tubers per plot and number of fresh tubers per plot. B2 treatment yields the highest crop, number of leaves), weight of fresh tubers per clump, number of fresh tubers per clump, weight of fresh tubers per plot. The interaction of the use of several types of mulch and various tuber weights has a noticeable effect on plant height, number of leaves, weight of fresh tubers per clump, number of fresh tubers per clump, weight of fresh tubers per plot and number of fresh tubers per plot.

Keywords: Bulb Weight; Mulch; Shallot; Production

Introduction

Shallots *(Allium ascalonicum L.)* are one of the important agricultural commodities for the lives of people in Indonesia. So that it includes horticultural crops that have the potential to be developed both from the lowlands to the highlands in Indonesia. This is the reason many farmers cultivate shallots and make it a livelihood.

The prospects of onion farmers are good. This can be seen from the needs of shallots. which is increasing in direct proportion to population growth. In Simalungun Regency, shallots are one of the basic commodities in the agricultural sector and have the potential to be developed (Saragih et al., 2021). Therefore, North Sumatra shallot business needs to be improved in quantity, quality, and continuity. Data BPS (2015) stated that shallot production in 2014 amounted to 7,810 tons.

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However, there was a decrease in production by 495 tons (5.96%). This decrease was caused by various factors, one of which was a decrease in productivity by 0.14 tons per hectare (1.74%). So it is necessary to import shallots to cover the shortage of shallot needs.

The low yield of shallots is caused by suboptimal cultivation techniques, as well as the fact that farmers do cultivation business seasonally (Hasanah et al., 2022). Farmers plant onions if climatic conditions are favorable. So production is limited.

Shallot productivity can be increased by improving cultivation and engineering where it grows. So that it can grow shallots out of season or outside the conventional cultivation environment. One of the cultivation techniques that needs to be improved is the selection of the right seeds. The seeds used can be determined the weight of onion bulbs. The weight of onion bulbs will affect growth and production (Uke et al., 2015).

The method that can be done is by engineering the microclimate, which uses various types of mulch. Efforts in engineering the microclimate to achieve optimum plant growth are one way to overcome environments with high and low rainfall. Most farmers do cultivation business in an open environment, as a result during the high rainy season many crops are damaged due to being hit by rainwater and disease. By using mulch, in addition to being able to withstand rainwater blows and pest attacks, a can optimize the use of fertilizers, pepticides, preserve soil moisture, and maintain soil temperature (Wisudawati & Iskandar Lapanjang, 2016)

Mulch is a material or material made of plastic or organic material used to cover the surface of the soil or agricultural land. The purpose of using this mulch is to increase crop production. The use of mulch can provide benefits, among others, saving water use by suppressing the rate of evaporation from the soil surface, minimizing soil temperature fluctuations, thus benefiting the growth of onion plants and soil microorganisms, reducing the rate of soil erosion both due to rain grains and can inhibit the rate of weed growth (Samosir, 2020).

This study aims to determine the effect of mulch type and bulb weight on the growth and yield of onion production (Allium ascalonicum L.). In detail this study aims to: (1) Know the type of mulch that is most suitable for the growth and production of onion plants; (2) Knowing the weight of bulbs is best for the growth and production of onion plants; (3) Know the interaction between the type of mulch and the weight of bulbs used for the growth and production of onion plants.

Method

Shallots (Allium ascalonicum L.) are one of the important agricultural commodities for the lives of people in Indonesia. So that it includes horticultural crops that have the potential to be developed both from the lowlands to the highlands in Indonesia. This is the reason many farmers cultivate shallots and make it a livelihood.

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Result and Discussion

Plant Height (cm)

Average data and the results of fingerprint analysis of the height of onion plants at the age of 2, 4 and 6 WAP, showed that the use of several types of mulch and the weight of bulbs had a significant effect on the height of onion plants. To determine the difference between treatments, testing was carried out using the Smallest Real Difference Test (BNT0.05) as in Table 1.

Table 1. Test Results of the Average Height of Shallot Plants with the Use of Several Types of Mulch and Various Bulb Weights.

Treatment	Plant Height (cm)		
	2 WAP	4 WAP	6 WAP
M0	16.00c	19.99c	32.11b
M1	24.23a	30.00a	38.00a
M2	18.89b	24.33b	25.77c
BNT	1.52	1.25	1.67
B0	18.01bc	24.22b	31.56b
B1	19.44b	22.76c	26.44c
B2	21.67a	26.56a	34.55a
BNT	1.52	1.25	1.67
M0B0	15.67	20.33h	34.33cd
M0B1	15.00	17.33i	29.00fg
MOB2	17.33	22.33f	33.00e
M1B0	21.67	28.00c	34.67c
M1B1	25.00	29.33b	38.00b
M1B2	26.00	32.67a	41.33a
M2B0	16.67	24.33de	25.67h
M2B1	18.33	21.33g	22.33i
M2B2	21.67	24.67d	29.33f
BNT		0.77	0.96

Remarks: Numbers followed by different lowercase letters in the same column show a marked difference at the level of 5%. WAP: week after planting

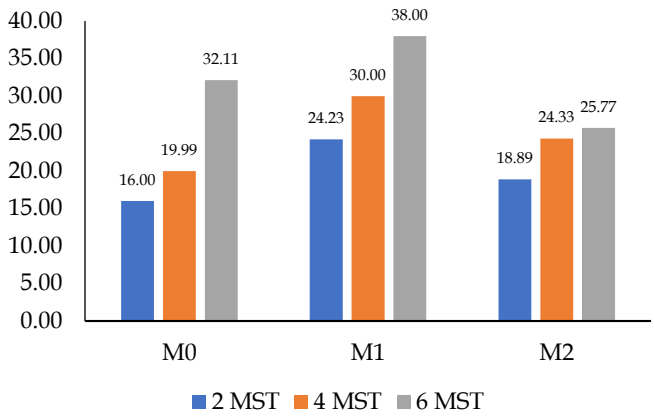

Figure 1. Plant Height histogram (cm) with some type of mulch

Figure 1 shows that the plant height at 6 WAP was highest at M1 (Silver Black Plastic) treatment which was 38 cm, which was significantly different from M2 (Rice Straw) but not significantly different from M0 (Control). The lowest plant height was found in the M2 treatment, which was 25.77 cm. The use of black silver plastic mulch has a significant effect on the growth of shallots.

Black silver plastic mulch can keep the soil temperature warm, so that the growth and development of roots becomes more optimal and the process of decomposition of nutrients by microorganisms becomes better (El-Beltagi et al., 2022). Silver black plastic absorbs sunlight energy and retains heat, then the heat transfers conductively from the black plastic mulch to the soil when it comes into direct contact with the soil (Arancibia, 2022). This situation can encourage the root system to absorb nutrients and water optimally and plants are able to carry out the process of photosynthesis which then the results of photosynthesis are used for leaf formation (Amare & Desta, 2021).

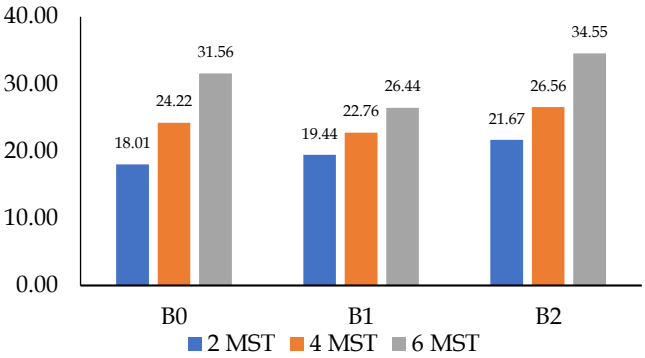

Figure 2. Plant Height Histogram (cm) with Treatment of Various Tuber Weights

Figure 2 shows the B2 treatment yielding the highest plant height of 34.55 cm, which differs markedly from B1 but differs unmarkedly from B0. The lowest plant height is found in B1 treatment, which is 26.44 cm. This is because large tubers have more realistic layers. So it can be said that the ability of large onion seedlings has a wider root cross-sectional area so that the number of roots that grow will be more (Nugroho et al., 2017). This means that the amount of nutrients that can be absorbed is in large quantities, thereby increasing plant growth.

Number of Leaves (strands)

Average data and the results of fingerprint analysis of the number of leeks show that the application of several types of mulch and the weight of bulbs have a significant effect on the number of shallots. To determine the difference between treatments, testing was carried out using the Smallest Real Difference Test (BNT0.05) which can be seen in Table 2.

Table 2. Test Results of Average Difference in Number of Leaves (Strands) with the Use of Several Types of Mulch and Various Tuber Weights

Treatment	Number of Leaves (strands)		
	2 WAP	4 WAP	6 WAP
M0	19.92b	21.78	24.22ab
M1	21.77a	22.22	24.70a
M2	18.96c	21.56	22.25c
BNT	0.58		0.94
B0	14.86a	19.23a	18.85c
B1	20.52b	21.34b	24.36b
B2	25.18c	25.78c	27.96a
BNT	0.58	1.11	0.94
M0B0	14.90gh	17.56	20.89g
M0B1	19.44d	21.23	23.89e
MOB2	25.44b	26.56	27.89b
M1B0	14.77hi	18.56	16.89i
M1B1	18.22e	20.89	22.77f
M1B2	23.89c	25.23	27.11c
M2B0	15.22f	19.23	18.77h
M2B1	23.89c	21.89	26.44d
M2B2	26.22a	25.56	28.89a
BNT	0.33		0.54

Remarks : Numbers followed by different lowercase letters in the same column show a marked difference at the level of 5%. WAP: week after planting

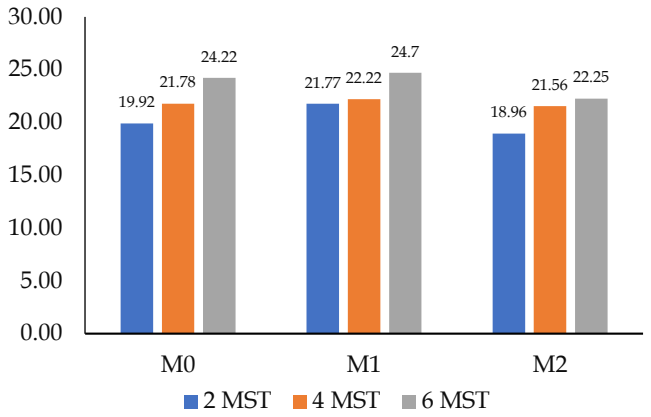

Figure 3. Histogram of Number of Leaves (Strands) with Treatment of Several Types of Mulch

Figure 3 shows that the number of leaves at 6 WAP is highest in the M1 (Silver Black Plastic) treatment which is 24.70 strands which is not significantly different from M0 (Control) and M2 (Rice Straw). The lowest number of leaves was found in the M2 treatment, which was 22.25 strands. Black silver plastic mulch treatment is able to maintain optimal soil temperature so as to optimize the rate of development of the root system which can help plants absorb nutrients and water to encourage the rate of photosynthesis in leaf formation. Black silver plastic mulch can keep the soil temperature warm, so that the growth and development of roots becomes more optimal and the process of decomposition of nutrients by microorganisms becomes better (El-Beltagi et al., 2022).

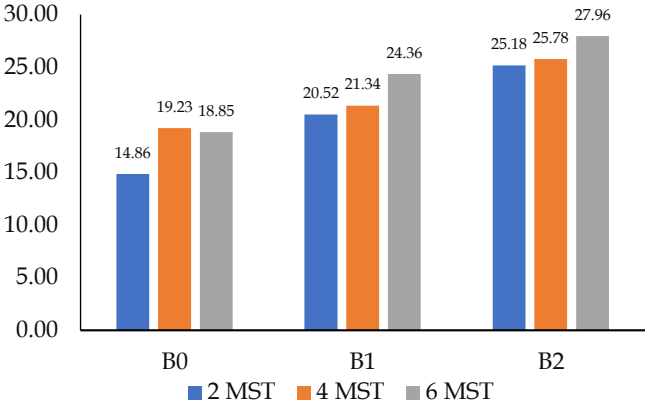

Figure 4. Histogram of Number of Leaves (Strands) with Treatment of Various Tuber Weights

Figure 4 shows the B2 treatment has the highest leaf count of 27.96 which differs not significantly from B1 but differs markedly from B0. When the plant enters the generative phase, the vegetative process that takes place will be reduced to replenish tubers / food reserves. The growth of shallots is greatly influenced by the weight of the bulbs used as seeds (Sufyati, 2006). Compared to the size of seedlings that are small in size,. Onion seeds that come from large bulbs will provide the formation of more plant leaves so that growth is better (Nugroho et al., 2017).

Weight of Fresh Tubers (g)

Table 3. Test Results of the Average Weight of Tubers (g) with the Use of Several Types of Mulch and Various Tuber Weights.

Treatment	Weight of Fresh Tubers per Clump (g)
M0	115.67bc
M1	148.22a
M2	120.44b
BNT	5.35
B0	110.56c
B1	132.00b
B2	141.77a
BNT	5.35
M0B0	98.67h
M0B1	118.00g
M0B2	130.33e
M1B0	138.67cd
M1B1	150.33b
M1B2	155.67a
M2B0	94.33i
M2B1	127.67ef
M2B2	139.33c
BNT	3.08

Remarks: Numbers followed by different lowercase letters in the same column show a marked difference at the level of 5%.

The average data and results of fingerprint analysis of the weight of fresh bulbs per clump can be seen from appendices 19 to 21 show that the application of several types of mulch and the weight of tubers have a significant effect on the weight of fresh bulbs per clump of shallots. To determine the difference between treatments, testing was carried out using the Smallest Real Difference Test (BNT0.05) which can be seen in Table 3.

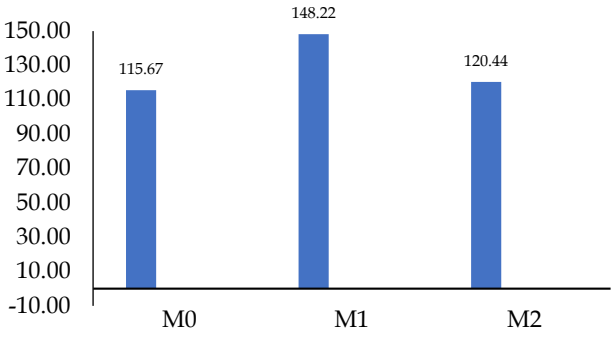

Figure 5. Histogram of Fresh Tuber Weight per Clump (g) with Treatment of Various Types of Mulch.

Figure 5 shows that the weight of the highest fresh tubers at M1 (Silver Black Plastic) is 148 g which is significantly different from other treatments. The lowest weight of fresh tubers was found in the M0 (Control) treatment, which was 115.67 g. This is because black silver plastic mulch provides a temperature that is in accordance with plant growth, resists the rate of evaporation of water in the soil so that soil moisture is maintained, and can help the root spreading process optimally.

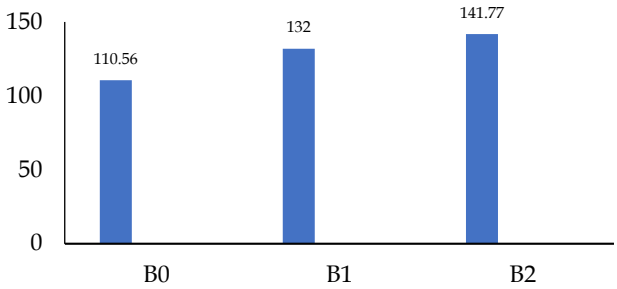

Figure 6. Histogram of Fresh Tuber Weight per Clump (g) with Treatment of Various Tuber Weights

Figure 6 shows that the B2 treatment has the highest weight of fresh tubers at 141.77 gr, and the lowest weight is found in the B0 treatment. According to research (Nugroho et al., 2017), explains that large tubers give higher yields compared to medium and small bulbs. The results showed that the increasingly heavy bulbs of the plant produced a large weight of tubers as well. Large tubers have more food reserves. This shows that the dominant chemical filling onion bulbs is carbohydrates. Carbohydrates are used for its growth. Fructan, which is a type of carbohydrate produced from sucrose and fructose, is the main carbohydrate reserve in most onion bulbs and is enzymatically hydrolyzed to fructose during onion bulb storage (Li et al., 2014).

Figure 7 shows the interaction of several types of mulch and various tuber weights resulting in the highest tuber weight found in the M1B2 treatment, which is 155.67 g which is significantly different from other treatments. The lowest weight of fresh tubers was found at the M2B0 treatment level, which was 94.33 g.

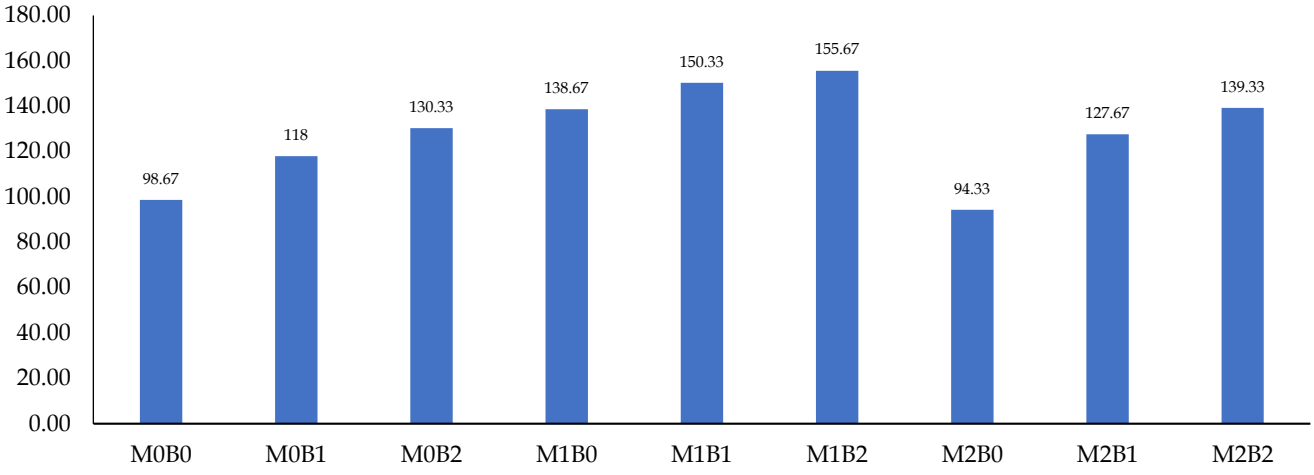

Figure 7. Histogram of Fresh Tuber Weight per Clump (g) with Combination Treatment of Different Types of Mulch and Tuber Weight

According to (Nugraha et al., 2014), In general, the use of black silver plastic mulch increases the temperature of the rhizosphere. Sunlight is transmitted through the surface of the soil it covers and forms a greenhouse effect on a small scale covered with plastic mulch that affects plant growth. In line with opinion (Nugraha et al., 2014), that black silver plastic mulch causes air temperature to increase and when it is in the phase of tuber formation and filling reaches 41.60C can increase respiration and reduce plant photosynthesis so that the photosynthetes produced by plants are also low, and furthermore food reserves stored in tubers and plant yields are also low.

Number of fresh tubers per clump (tubers)

Average data and the results of fingerprint analysis of the number of fresh bulbs per clump show that the application of several types of mulch and the weight of the bulbs have a significant effect on the number of fresh bulbs per clump of shallots. To determine the difference between treatments, testing was carried out using the Smallest Real Difference Test (BNT0.05) which can be seen in Table 4.

Table 4. Test Results of the Average Difference in the Number of Tubers (tubers) with the Use of Several Types of Mulch and Various Tuber Weights.

Treatment	Number of Fresh Tubers per Clump (tubers)
M0	33.44b
M1	44.00a
M2	32.11bc
BNT	1.86
B0	31.00c
B1	37.66b
B2	40.89a
BNT	1.86
M0B0	28.33h
M0B1	33.33fg
M0B2	38.67de
M1B0	41.67c
M1B1	45.33a
M1B2	45.00ab
M2B0	23.00i
M2B1	34.33f
M2B2	39.00d
BNT	1.07

Remarks: Numbers followed by different lowercase letters in the same column show a marked difference at the level of 5%

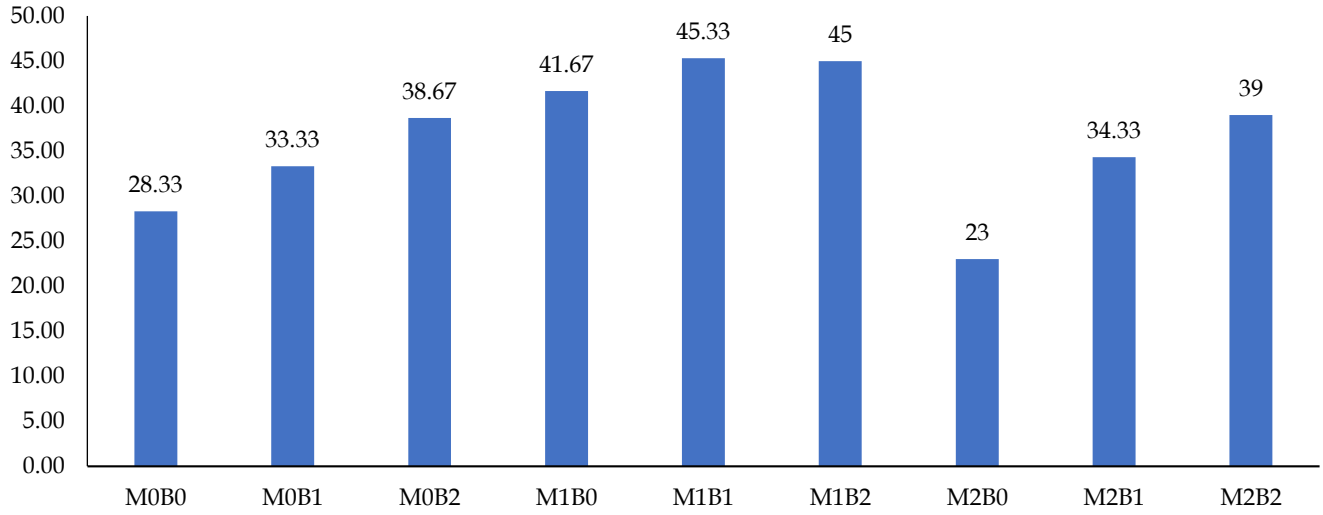

Figure 8. Histogram of Number of Fresh Tubers per Clump (tubers) with Combination Treatment of Different Types of Mulch and Tuber Weight

Table 4 shows that the highest number of tubers was found in the M1 (Silver Black Plastic) treatment, which was 44 tubers that were significantly different from other treatments. The lowest number of tubers is found in the M2 (Rice Straw) treatment. Black silver plastic mulch gives the highest number of fresh tubers. This is due to the influence of mulch from black silver plastic providing good soil physical conditions for onion growth. The good physical condition of the soil makes plant growth more optimal, starting from its growth, leaf formation, plant weight, tuber weight and affects the number of tubers in plants (Utomo, 2016).

Table 4 shows that B2 treatment has the highest number of fresh tubers at 40.89 tubers, with B0 having the lowest number of fresh tubers at 31 tubers. Using real large bulbs gives a higher number of fresh tubers per clump compared to the weight of other tubers. The leeks formed will be more than small seeds, because large seeds will provide good growth. The increase in the process of photosynthesis will affect the size of the leek area so that it affects the process of onion bulb formation.

Photosynthesis is an important process for onion growth and bulb formation. For example, onion photosynthesis and stomatal conductance increase at the onset of bulbs, which seem to provide carbohydrates for growth and storage in bulbs (Bachie et al., 2019)

Figure 8 shows the interaction of several types of mulch and various tuber weights resulting in the highest number of fresh tubers found at the M1B1 treatment level of 45.33 tubers which is significantly different from other treatment levels. The lowest number of fresh tubers was found at the M2B0 treatment level, which was 23 tubers. The use of silver plastic mulch by the weight of tubers gives the best results.

Weight of fresh tubers per plot (kg)

Average data and the results of fingerprint analysis of the variety of fresh bulb weight per plot showed that the application of several types of mulch and the weight of the bulbs had a significant effect on the weight of fresh bulbs per onion plot. To determine the difference between treatments, testing was carried out using the Smallest Real Difference Test (BNT0.05) which can be seen in Table 5.

Table 5. Test Results of the Average Difference in Tuber Weight Per plot (Kg) with the Use of Several Types of Mulch and Various Tuber Weights.

Treatment	Weight of Fresh Tubers per Plot (Kg)	Berat Umbi Segar (ton/ha)
M0	1.76 b	2.93
M1	1.97 a	3.28
M2	1.62 c	2.70
BNT	0.09	
B0	1.52 c	2.53
B1	1.73 b	2.88
B2	2.11 a	3.51
BNT	0.09	
M0B0	1.38hi	2.30
M0B1	1.69f	2.81
M0B2	2.22b	3.70
M1B0	1.77e	2.95
M1B1	1.85c	3.08
M1B2	2.30a	3.83
M2B0	1.41h	2.35
M2B1	1.64fg	2.73
M2B2	1.81cd	3.01
BNT	0.05	

Remarks: Numbers followed by different lowercase letters in the same column show a marked difference at the level of 5%

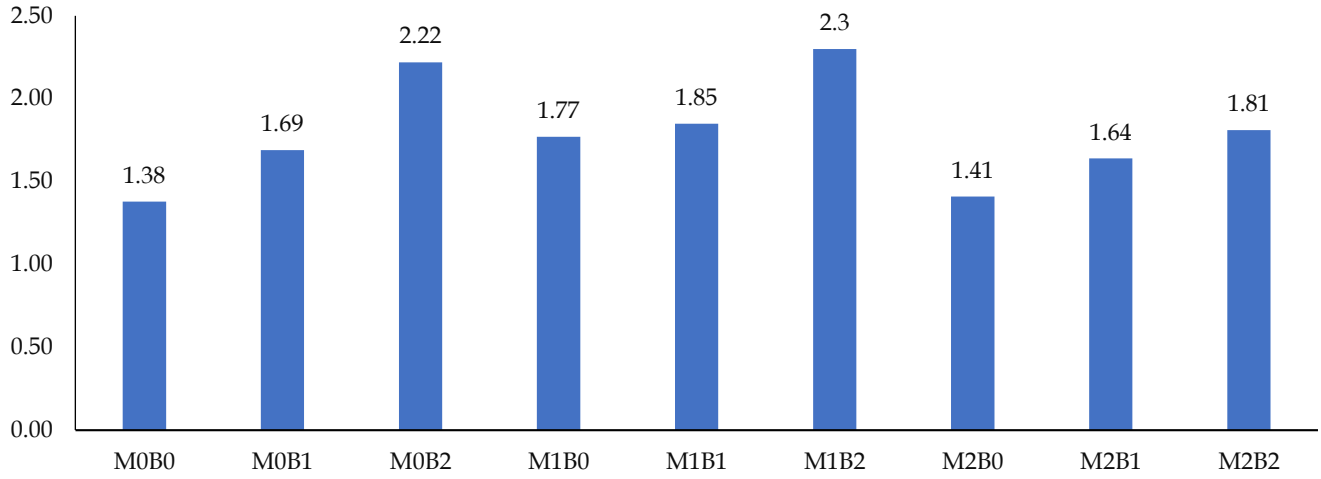

Figure 9. Histogram of Fresh Tuber Weight per Plot (Kg) with Combination Treatment of Different Types of Mulch and Tuber Weight

Table 5 shows that the highest weight of fresh tubers per plot is found in the M1 (Silver Black Plastic) treatment, which is 1.97 kg, which is significantly different from other treatments. And the lowest is found in the M2 (Rice Straw) treatment, which is 1.62 kg. This is because black silver plastic mulch is able to create microclimate conditions and good soil structure so that plants can grow optimally, get adequate supply of water, air and nutrients (Utomo, 2016). Soil with loose soil structure is beneficial for plants because the root system can run well so as to increase the ability of plants to absorb a lot of water, nutrients, and air. Good soil structure improves soil pore space, allowing for better water infiltration, root growth, and nutrient absorption (Utomo, 2016)

Soil structure is essential for plant growth and provides an environment for plants to grow by tethering roots and storing nutrients. It also supports biodiversity by providing diverse habitats for the many organisms that live in it. In turn, soil organisms, such as earthworms, can directly change the structure of the soil. The root system of plants releases compounds that can

bind soil particles together. The relationship between soil structure and soil communities is complex, and different groups of organisms respond differently to changes in soil structure (Arnold et al., 2020)

Table 5 shows that the B2 treatment has the highest tuber weight of 2.11 kg, and the lowest is found in the B0 treatment weighing 1.62 kg. According to research by Deviana (2014), explained that large tubers give higher yields compared to medium and small tubers. The results showed that the increasingly heavy bulbs of the plant produced a large weight of tubers as well.

Figure 9 shows the interaction of several types of mulch and various tuber weights having the highest weight of fresh tubers per plot found at the M1B2 treatment level weighing 2.30 kg which is significantly different from other treatment levels. And the lowest is found at the M0B0 treatment level with a weight of 1.38 kg. Research using several types of mulch shows different influences on tuber weight. This is because, treatment with mulch can have a good impact on planting media plants, especially on crop production itself. The use of mulch can increase the wet weight of tubers and the dry weight of selling tubers (Novayana et al., 2015)

Conclusion

The treatment of several types of mulch has a significant effect on plant height, weight of fresh tubers per clump, number of fresh tubers per clump, weight of fresh tubers per plot and number of fresh tubers per plot. M1 black silver plastic mulch treatment resulted in the highest plant height aged 2, 4 and 6 WAP respectively (24.33 cm), (30.00 cm) and (38.00 cm), weight of fresh tubers per clump (148.22 g), number of fresh tubers per clump (44 tubers), weight of fresh tubers per plot (1.97 kg) or (3.28 tons/ha) respectively. Tuber weight treatment has a noticeable effect on plant height, number of leaves, weight of fresh tubers per clump, number of fresh tubers per clump, weight of fresh tubers per plot and number of fresh tubers per plot. B2 treatment produced the highest plants at the age of 2, 4 and 6 WAP respectively (21.67 cm), (26.56 cm) and (34.55 cm), number of leaves respectively (25.18 strands), (25.78 strands) and (27.96 strands), weight of fresh tubers per clump (141.77 g), number of fresh tubers per clump (40.89 tubers), weight of fresh tubers per plot (2.11 kg) or (3.51 tons/ha). The interaction of the use of several types of mulch and various tuber weights has a noticeable effect on plant height, number of leaves, weight of fresh tubers per clump, number of fresh tubers per clump, weight of fresh tubers per plot and number of fresh tubers per plot. The interaction of M1B2 produced the highest crops at the age of 2, 4 and 6 WAP respectively (26.00 cm), (32.67 cm) and (41.33 cm), weight of fresh tubers per clump (155.67 g), weight of fresh tubers per plot (2.30 kg) or (3.83 tons/ha).

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Conflicts of Interest
The authors declare no conflict of interest.

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