Original Research Article

Effect of mulches types use and chicken manure doses to growth and yield of shallot

ABSTRACT

Aims: The research aimed to study the interaction of mulch types and chicken manure doses to growth and yield of shallot.

Study design: Factorial design in completely randomized design with 2 factors

Place and Duration of Study: The research was conducted in Panai Pasir Talang, Muaralabuh, South Solok Regency, West Sumatera, Indonesia from December 2018 to February 2019. The altitude of research site was 430 meter above sea level (asl).

Methodology: Factorial design in completely randomized design with 2 factors was used in the research. First factor was much types (black plastic, silver plastic mulch and rice straw mulch). The second factor was chicken manure dose (10 ton/ha, 20 ton/ha and 30 ton/ha). The data was analyzed by Duncan's New Multiple Range Test in 5%

Results: The result showed that there was no effect of the interaction between mulch types use and chicken manure doses on growth and yield of shallot. For single factor, the black plastic mulch was the best treatment for fresh tuber weight per hectare (11.74 ton/ha). 20 ton/ha of chicken manure dose affected the plant height, number of leaves, fresh tuber weight per hectare and dry weight per hectare.

Conclusion: There was no treatment can be conducted for increasing the growth of shallot.

Keywords: Chicken manure, mulch, shallot, yield

1. INTRODUCTION

Shallot (*Allium ascolanicum*) is one of vegetable commodities that have been cultivating in almost part of Indonesia [1]. In addition to use as spices, shallot also can be sold as extract, powder, cooking oil even as medicine to decrease the cholesterol, blood sugar, avoiding the blood clotting, decreasing the blood pressure and expediting the blood flow [2]. As important commodities, shallot development potency is widely opened even can be exported to other countries [3].

In last decade, the shallot requirement of Indonesia for consumption increases 5%. This condition is caused by the increasing of Indonesian population [4]. From 2013-2015, the shallot production of Indonesia was 1.010.773 ton, 1.233.984 ton and 1.229.184 ton, respectively. According to the Ministry of Indonesian Agriculture (2016) [5], harvesting area of shallot from 2013-2015 was 98.937 ha, 120.704 ha and 122.126 ha, respectively. To suffice the national demand, Indonesia also imports 74.019 ton of shallot from other countries such as India, Thailand, Vietnam and Philippines. This condition causes the government should find the solution to increase the national shallot production.

Shallot cultivation has a high risk, many challenges and obstacles that faced in its cultivation such as pests and diseases that is the main obstacle in shallot cultivation. Low productivity and pest and diseases attack always increase and generally occur in off season cultivation. Shallot can not stand in watery land due to the disease appearance under this condition, particularly from fungi [6].

One of efforts to solve the problem is environmental modification such as mulch application. Mulch presence to cover the soil surface, the rain will be held by mulch so that the soil aggregate is stable and avoided from the destruction

process [7]. Not all mulch can be used for controlling the soil erosion. The mulch technology can prevent the evaporation. In this case, the evaporated water from soil surface will be held by mulch and fall down to soil [8].

Organic mulch has low heat conductivity, so that the heat in soil surface is lower than high heat conductivity such as plastic mulch. Mulch use effectiveness in tropical region is obtained from this mulch to protect the soil from direct rain, blow up the soil, prevent to nutrients leaching, water evaporation and slow down the soil carbon dioxide of microorganism activity respiration [9]. The color of plastic mulch surface has optic ability in changing the light quality and quantity so that it can be used by plant to do the growth process [10]. Ansar (2012) [11] reported that the straw and silver black plastic mulches application could increase the bulb fresh weight 29.3% and 24.7%, respectively.

Recently, shallot cultivation depend on the inorganic fertilizer but this fertilizer has negative impact particularly for environment. The impact of long term inorganic fertilizer application is soil damage, water pollution and the disruption of ecosystem [12]. Therefore, an alternative fertilizer should be found to maintain soil aggregate and ecosystem balance. The fertilizer type can be used to solve the problem is organic fertilizer. Organic fertilizer has many advantages such as improving the biology, physical and chemistry of soil and no negative impact for ecosystem [13].

The awareness of sustainable agriculture and difficulty to obtain and expensive of inorganic fertilizer for farmers also leads the research to cheap organic waste use, available and environmental friendly. One of organic matter type is chicken manure. The chicken manure is the source of macro and micro nutrients that can increase the soil fertility and substrate for soil microorganism and increase the microbe activity, so that the decomposition become faster and releases the nutrients. Chicken manure is important nutrients due to it contains higher nitrogen and phosphate than other manures such as N 3.21%, P_2O_5 3.21%, K_2O 1.57%, Ca 1.57%, Mg 1.44%, Mn 250 ppm and Zn 315 ppm [14] Previous research reported that 15 ton/ha of chicken manure use resulted 13.44 ton/ha of shallot dry bulb. Jazilah et al. (2007) [15] also reported that 20 ton/ha of chicken manure increased the fresh bulb weight per clump, dry bulb weight and bulb volume. The current investigation is aiming to study the effect of interaction between mulch types and chicken manure doses on growth and yield of shallot.

2. MATERIAL AND METHODS

2.1 Place, time and material

The research was conducted in Panai Pasir Talang, Muara Labuh, South Solok Regency, West Sumatera, Indonesia from December 2018-July 2019. The research site was 1.498ºS and 101.06ºE and the altitude was 430 meter above sea level (asl). The soil type of research site was Andosol. The used materials were shallot bulb of Bima Variety, chicken manure, silver black plastic mulch, rice straw, fertilizer (NPK phonska, SP-36 and ZA). The tools were tractor, hoe, knife, sprayer tank, bamboo, digital scale, camera and stationary.

2.2 Method

Factorial design in completely randomized design with 2 factors was used in the research. The first factor was mulches types and the second factor was chicken manure doses.

The mulches application consisted of 3 treatments as follows:

Black plastic mulch	(M1)
Silver black plastic mulches	(M2)
Rice straw mulch	(M3)

Chicken manure doses consisted of 3 treatments as follows:

10 ton/ha	(P1)
20 ton/ha	(P2)

30 ton/ha (P3)

According to the combined treatments, 9 treatment combinations were obtained with 3 replicates, so that 27 experimental unit were obtained. For each experimental unit, it consisted of 35 plants, so that 945 plant population were obtained, and 6 plants were selected in each plot as sampling. F table in 5% and continued by Duncan's New Multiple Range test were used to analyze the data.

2.3 Procedure

The tillage was conducted 2 times with interval a week. The first tillage was conducted by plowing by tractor with 20-30 in depth. The second tillage was conducted by using hoe. The plot sized 1.4 m x 1 m was made with 30 cm in depth as many as 27 plots. The space among the plots was 30-40 cm.

The next step is each experimental unit was applied by treatments. The chicken manure was applied according to the doses by sowing evenly for each plot and left for a week. The next treatment was mulches application. The black plastic mulch and silver black was laid before planting in daytime. Then the edges of mulch was nailed down. The rice straw application was conducted by cutting the straw 10 cm in length and sowed evenly in plots.

The planting was started in third week, after chicken manure application and mulch application in each plot. Bima variety with similar size was used for seedling in the assay. Before planting, the holes were made to lay the bulb when planted. The plant spacing was 20 cm x 20 cm. Before planting, the bulb was cut in top around 1/3 part and then covered by soil and top of seedling was left.

The fertilization was used in the assay by using NPK phonska 500 kg/ha and Sp-36 100 kg/ha and ZA 200 kg/ha. The application was half recommendation and conducted as follows 35 g/plot of NPK phonska, 7 g/plot of SP-36 and 14 g/plot of ZA. The fertilization was conducted 2 times. First one was conducted 7 days after planting and the second one was conducted 35 days after planting.

The observed parameters were plant height, number of leaves, number of bulbs per clump, weight of fresh weight per hectare and weight of dry weight per hectare.

2. RESULTS AND DISCUSSION

3.1. Plant height

The result showed that there was no effect of the interaction between mulch types and chicken manure doses to plant height of shallot. However, for single factor, chicken manure dose affected the plant height. According the result, 20 ton/ha and 30 ton/ha were better than 10 ton/ha application (Table 1).

Table 1. Plant height of shallot as affected by application of mulch types and chicken manure doses (cm)

Mulch types	Doses of chicken manure			Average
	10 ton/ha	20 ton/ha	30 ton/ha	
Black plastic mulch	40.47	44.07	43.03	42.53
Silver plastic mulch	39.13	42.00	42.33	41.15
Rice straw mulch	40.63	43.47	45.83	43.31

Average	40.08 B	43.18 A	43.73 A
Coefficient of variation: 5.31%			

Note: similar letter indicates not significantly different

There was no effect by interaction between mulches and chicken manure doses was caused by generally essential nutrients were not required by plants during vegetative phase. Single factor application, chicken manure dose affected the plant height due to the chicken manure provided the nutrients such as nitrogen, phosphorus and potassium that could be well absorbed by plant. These nutrients played significant role for plant height. Nitrogen played role to increase vegetative growth such as leaves, root, shoot appearance and increasing the plant growth. N deficiency caused the plant could not grow well and the plant underwent stunted and the leaves color was light green and finally yellowing [16].

Fertilization is an effort to comply plant nutrients requirements where manure is one of organic matter that could fertilize soil and increases the growth and yield of plant. Chicken manure contained macro nutrients and their contain were 3 times higher than other manure. Plant height is a physiological process where the cell conducts the division. In cell division, the plant requires high essential nutrients and absorbed by roots. Cell division causes the increasing of plant height [17].

3.2 Number of leaves

Number of shallot leaves was not affected by the interaction between mulch types and chicken manure doses, but the number of leaves was affected by single factor, chicken manure doses. According to the result, 30 ton/ha of chicken manure dose was the best treatment for number of leaves (30.70). The chicken manure application increased the essential nutrients particularly nitrogen, phosphorus and potassium. Nitrogen played role for plant tissue formation.

Chicken manure is one of common organic matter. The organic matter is able to improve soil physic, biology and chemical to support plant productivity. The organic matter addition released the nutrients such as nitrogen, phosphorus, potassium, calcium and magnesium and provided the nutrients availability for plan [18]. In soil biology improvement, organic matter could increase microorganism population that played important role for decomposition. Manure also support to neutralize soil pH, increasing soil porosity so that increasing water availability and helping the nutrients absorption of chemical fertilizer addition [9].

Table 2. Number of leaves of shallot as affected by application of mulch types and chicken manure doses

Mulch types	Doses of chicken manure			Average
	10 ton/ha	20 ton/ha	30 ton/ha	
Black plastic mulch	26.37	31.47	27.50	28.45
Silver plastic mulch	25.13	29.17	32.60	28.97
Rice straw mulch	22.03	25.17	32.00	26.04
Average	24.51 B	28.60 AB	30.70 A	
Coefficient of variation : 13.01%				

Note: similar letter indicates not significantly different

The main role of nitrogen is to stimulate the entire plant growth particularly stem, branch and leaves. Due to during generative stage of shallot in this case plant growth and leaves formation, if the plant underwent well growth and formed the perfect leaves, the formation bulb process also well developed [19]. The shallot plant that obtained the sufficient nutrients formed wide leaves and contained high chlorophyll content so that the plant produced sufficient assimilate to support vegetative growth [20].

3.3 Number of bulb per clump

The number of bulb per clump was not affected by the interaction between mulch types and chicken manure doses. The single factor also did not affect the result (Table 3). The result of number of bulb per clump is shown in Figure 1. This condition caused by genetic factor. In addition, the good environmental condition also affected the number of bulb. The environmental condition was optimal due to the chicken manure and mulches application.

Table 3. Number of bulb of shallot as affected by application of mulch types and chicken manure doses

Mulch types	Doses of chicken manure			Average
	10 ton/ha	20 ton/ha	30 ton/ha	
Black plastic mulch	7.16	7.96	7.06	7.39
Silver plastic mulch	7.00	7.03	7.46	7.16
Rice straw mulch	7.06	7.00	8.00	7.35
Average	7.07	7.33	7.50	
Coefficient of variation: 10.20%				

Note: similar letter indicates not significantly different

The bulb formation was started from enlarge and fused leaves layer. Layer formation was formed from nitrogen mechanism. Nitrogen caused the chemical process produced nucleic acid that played role in nucleus of cell division. This condition caused the layer well formed and developed to be shallot bulb [21].

Figure 1. Number of bulb per clump of shallot as affected by application of mulch types and chicken manure doses

3.4 Fresh weight of bulb per hectare

The result showed that the interaction between mulch types and chicken manure doses application did not affect the fresh weight of bulb per hectare of shallot. But, for single factor, both of single factor affected the fresh weight per hectare. According to the result of mulch types application, black plastic mulch was the best treatment for fresh weight of bulb per hectare (11.74 ton). For chicken manure doses application, 20 and 30 ton/ ha were better than 10 ton/ha for result per hectare (12.18 and 11.73 ton, respectively)(Table 4).

Table 4. Fresh weight of shallot bulb per hectare as affected by application of mulch types and chicken manure doses (ton)

Mulch types	Doses of chicken manure			Average
	10 ton/ha	20 ton/ha	30 ton/ha	
Black plastic mulch	11.17	12.03	12.03	11.74 a
Silver plastic mulch	10.43	12.07	12.40	11.63 ab
Rice straw mulch	10.03	11.10	12.10	11.08 b
Average	10.54 B	11.73 A	12.18 A	
Coefficient of variation: 6.30%				

Note: similar letter indicates not significantly different

Black plastic and silver plastic mulches caused the environmental condition for bulb growth optimal particularly air and soil temperature that played important role for physiology and growth of plant. Black plastic mulch had absorption ability up to 90% to sunlight [22]. The strength of absorption was important to control soil temperature so that it was good for plant cultivation in high land such as shallot, asparagus and horticulture. The increasing of temperature until certain limit could increase net photosynthesis, but in over-optimal temperature, the yield decreased sharply due to respiration [23]. The soil temperature in mulches application caused the optimal temperature for microbes activity to decompose organic matter that was nutrients that could be absorbed by plant root. In this condition, microbes activity increased so that the nutrients in soil also increased. Previous research reported that the mulch application could maintain soil temperature stable and also could maintain soil moisture than untreated mulch. Plastic mulch was able to suppress higher evaporation rate than rice straw mulch, husk and reed [24].

The mulch could avoid evaporation. In this case, the evaporated water from soil was held by much and felt down to soil. This condition caused the water was always available for plant due to the loss water just occurred in transpiration. Several research reported that black plastic mulch could increase number of bulb per clump of shallot (6.40) [25]. The bulb formation process was dominantly affected by low soil temperature in night which stimulated bulb formation hormone appearance of plant. One of mulch application goal is to modify the micro climate of plant so that the cultivated plant grow and develop well. Micro climate was significantly affected by sunlight and physical factor of soil .

Several researches reported that 20 ton/ha of chicken manure dose was the best treatment for shallot yield. Jazilah et al. (2007) [15] reported that this dose affected fresh weight per clump, dry weight per clump and bulb volume. Maximal growth and yield of plant was not only determined by sufficient nutrients, but also determined by physical and biology of soil. The soil physical improvement was represented by the increasing of soil pores that supported the bulb enlargement [9].

3.5 Dry weight of bulb per hectare

According to the result, the interaction between mulch types and chicken manure doses application did not affect the dry weight of shallot bulb per hectare. The single factor, chicken manure doses affected the dry weight of bulb. The result showed that 20 and 30 ton/ha were the best treatment for dry weight of bulb per hectare (Table 5).

Table 5. Dry weight of shallot bulb per hectare as affected by application of mulch types and chicken manure doses (ton)

Mulch types	Doses of chicken manure			Average
	10 ton/ha	20 ton/ha	30 ton/ha	
Black plastic mulch	9.73	10.57	10.43	10.24
Silver plastic mulch	8.96	10.53	10.60	10.03
Rice straw mulch	8.53	9.57	10.77	9.62
Average	9.08 B	10.22 A	10.60 A	
Coefficient of variation: 6.7%				

Note: similar letter indicates not significantly different

The chicken manure contained nitrogen 3 times than other manure types. If the nitrogen is sufficient, the growth and development of plant underwent well. Nitrogen is main material for chlorophyll of photosynthesis and phosphorus played a role for meristematic cell division and potassium increased the metabolism role in plant body [18]. The sufficient nutrients availability is positively related to bulb formation. Prajapati and Modi (2012) [26] stated that if potassium was sufficient

could increase shallot growth more optimal and showed the better result. Shrinkage occurred due to during the drying bulb process, the evaporation occurred.

Dry weight is the balance of photosynthesis and respiration. The photosynthesis caused the dry weight due to the CO_2 taking while the respiration cause the decreasing of dry weight. The plant yield was more accurate if stated by dry weight measure due to the dry weigh was not affected by moisture [27].

4. CONCLUSION

There was no effect of the interaction between mulch types use and chicken manure doses on growth and yield of shallot. For single factor, the black plastic mulch was the best treatment for fresh tuber weight per hectare (11.74 ton/ha). 20 ton/ha of chicken manure dose affected the plant height, number of leaves, fresh tuber weight per hectare and dry weight per hectare.

REFERENCES

1. Holish, Murniyanto E, Wasonowati C. Effect of high beds on two local varieties of shallots (*Allium ascalonicum* L.). Agrovigor. 2014; 7(2): 84 – 89

2. Motlagh HRM, Mostafaie A, Mansouri K. Anticancer and anti-inflammatory activities of shallot (*Allium ascalonicum*) extract. Arch. Med. Science. 2011; 1: 38-44

3. Pasaribu TW, Daulay M. Analysis of shallot import requirement in Indonesia. Jurnal Ekonomi dan Keuangan. 2013; 1(4): 14-26

4. Statistics Indonesia. Shallot consumption of Indonesia. 2020; Accessed 31 January 2020. https://www.pertanian.go.id/

5. Ministry of Agriculture of Indonesia. Shallot production of Indonesia. 2020; Accessed 31 January 2020. https://www.pertanian.go.id/

6. Rahayu E, Berlian VA. (2004). Shallot. Penebar Swadaya. Jakarta

7. Teame G, Tsegay A, Abrha B. Effect of organic mulching on soil moisture, yield and yield contributing components of Sesame (*Sesamum indicum* L.). International Journal of Agronomy. 2017; 4767509: 1-6

8. Ranjan P, Patle GT, Prem M, Solanke KR. Organic mulching- a water saving technique to increase the production of fruits and vegetables. Current Agriculture Research Journal. 2017; 5(3): 371-380

9. Bucki P, Siwek P. Organic and non-organic mulches-impact on environmental conditions, yields, and quality of Cucurbitaceae. Folia Horticulturae. 2019; 31(1): 129-145

10. Qu B, Liu Y, Sun X, Li S, Wang X, Xiong K, Yun B, Zhang H. Effect of various mulches on soil physico-chemical properties and tree growth (Sophora japonica) in urban tree pits. Plos One. 2019; 14(2): 1-12

11. Ansar M. (2012). The growth and yield of shallot in various height land. P.hD Dissertation. University of Gadjah Mada. Yogyakarta. Indonesia

12. Sofyan ET, Sara. The effect of organic and inorganic fertilizer application on N, P and K uptake and yield of sweet corn (*Zea mays* saccharata Sturt). J. Trop Soils. 2018; 23(3): 111-116

13. Makinde EA, Ayoola OT. Growth, Yield and NPK Uptake by Maize with Complementary Organic and Inorganic Fertilizers. Afr J Agr. 2010; 10: 2203-2217

14. Biratu GK, Elias E, Ntawuruhunga P, Nhamo N. Effect of chicken manure application on cassava biomass and root yields in two agro-ecologies of Zambia. Agriculture. 2018; 8(45): 1-15

15. Jazilah, Sunarto and Farid. Response of 3 shallot varieties to manure types and four inorganic fertilizer doses. Jurnal Penelitian dan Informasi Pertanian. 2007; 11(1): 1-8

16. Olivar VT, Torres OGV, Patino MLD, Nava HS, Martinez AR, Aleman RMM, Aguilar LAV, Tejacal IA. Role of nitrogen and nutrients in crop nutrition. Journal of Agricultural Science and Technology. 2014; 4: 29-37

17. Fiorani F, Beemster GTS. Quantitative analyses of cell division in plants. Plant Molecular Biology. 2006; 60: 963-979

18. Gmach MR, Cherubin MR, Kaiser K, Cerri EP. Process that influence dissolved organic matter in the soil: a review. Scientia Agricola. 2018; 77(3): 1-10

19. Krontal Y, Kamenetsky R, Rabinowitch D. Flowering physiology and some vegetative traits of short-day shallot: A comparison with bulb onion. Journal of Horticultural Science and Biotechnology. 2000; 75(1): 35-41

20. Marpaung AE and Rosliani R. (2019). Adaptability of growth and yield on 5 varieties of shallot (Allium ascalonicum L.) in wet highland. Journal of Tropical Horticulture, 2(1), 1-5

21. Hilman Y, Sopha GA, Lukman L. Nitrogen effect on production, nutrients uptake and nitrogen use efficiency of shallot (*Allium cepa* var aggregatum). Advances in Agriculture and Botanics-International Journal of the Bioflux Society. 2014. 6(2), 128-133

22. Mahadeen AY. Effect of polyethylene black plastic mulch on growth and yield of two summer vegetable crops under rain-fed conditions under semi-arid region conditions. American Journal of Agricultural and Biological Sciences. 2014; 9(2): 202-207

23. Gobel L, Coners H, Hertel D, Willinghofer S, Leuschner C. The role of low soil temperature for photosynthesis and stomatal conductance of three graminoids from different elevations. Frontiers in Plant Science. 2019; 10(330): 1-9

24. Manyatsi AM, Similane GR. The effect of organic mulch on the growth and yield of spinach (Spinaca oleracea L.). International Journal of Environmental and Agriculture Research. 2017; 3(6): 53-56

25. Woldetsadik K, Gertsson A, Ascard J. Response of shallots to mulching and nitrogen fertilization. HortScience. 2003; 38(2): 217-221

26. Prajapati K, Modi HA. 2012. The importance of potassium in plant growth: a review. Indian Journal of Plant Science. 2012; 1; 177-186

27. Huang W, Ratkowsky DA, Hui C, Wang P, Su J, Shi P. Leaf Fresh Weight Versus Dry Weight: Which is Better for Describing the Scaling Relationship between Leaf Biomass and Leaf Area for Broad-Leaved Plants?. Forest. 2019; 10(256): 1-19