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Research paper

Examining Organic Mulch Sheet on the Growth and Yield of Shallot (*Allium ascalonicum* L.)

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Abstract

Shallot is a vegetable commodity with a high economic value, as a source of farmers' income and foreign exchange. The National productivity of shallot in East Java continues to decrease. In the year of 2010, the production reached 9.98 tons/ha, and it declined to 9.34 tons/ha in 2013. One of the obstacles of shallot production is uncertain climate condition. Mulching is one of the efforts to control the microclimate around the plant. Organic mulch engineering into organic paper mulch is expected to overcome the above problem. The basic principle refers to the process of manufacturing synthetic paper. The research was conducted at the Experimental Farm of Faculty of Agriculture, University of Muhammadiyah Malang. The study used simple-randomized block design to test the treatment of organic material composition which consists of 6 treatments, and each treatment is repeated three times. The treatment is the basic material composition of water hyacinth plants as fine fibers, straw as rough fiber materials and leather waste as decomposing fiber material and flexibility. Observed variables include the growth and yield of shallot, climate and physical test. Each data is analyzed by F test and comparison test (Honest Significant Difference or HSD 5%). Based on comparative tests on the diameter of tuber, the number of tuber, fresh weight and dry weight it indicates that the use of organic paper mulch on treatment A where hyacinth plants: Straw: Waste Leather (5: 3: 2) and B where hyacinth plants: Straw: Waste Leather (5: 2: 3) is significantly different compared with other treatments. Increasing of fresh weight by applying organic mulch sheet and 103,73% more than non mulch and 36,84 % more than black silver plastic mulch. whereas the effect of organic paper mulch on vegetative phase of shallot is not significant.

Keywords: *Mulch, Organic Mulch Sheet, Shallots*

1. Introduction

Shallot is a vegetable commodity with a high economic value in terms of the fulfillment of national consumption, the source of income for farmers, as well as its potential as the earner of foreign exchange of the country. In line with the increasing population in 2012 from 49.53% to 50.17% in 2013, the supply of shallot needed to meet domestic demand is projected to rise to 976,284 tons. The total supply which is about 1.2 times national production is not only a challenge but also a development opportunity. National shallot production in 2013 amounted to 965,164 tons of 104,009 ha harvested area with the productivity 9,28tonnes/ha, while shallot production in East Java was higher i.e. 9.34% (Department of Agriculture, 2014).

Sustainable Agriculture is an agriculture technique which goes back to the mindset 'back to nature'. Climate change has a negative effect on nature, i.e. the increasing carbon emissions in the atmosphere (Hidayati & Suryanto, 2015; Rejekningrum et al., 2011). Intergovernmental Panel on Climate Change (IPCC) shows that global surface temperature increases by 1.1° C to 6.4° C between 1990 and 2100 (IPCC (Intergovernmental Panel on Climate Change), 2013).

The continuous use of inorganic materials in the soil can lead to erosion, changes in temperature, changes in precipitation and depletion of organic matter (Jenni, Brault, & Stewart, 2004). Mulching is a material spread on the surface of a crop with the intention to preserve soil moisture, reduce evaporation, suppress weeds and retain soil temperature fluctuation (Azad, Hassandokht, & Parvizi, 2015; Coolong, 2012; Yaghi, Arslan, & Naoum, 2013). Mulch material such as plastic is very effective in controlling soil water evaporation and atmospheric heat loss at night (Miles et al., 2012). The manufacture and use of organic paper mulch are very effective and relatively inexpensive. Paper made from the fiber can proceed from natural cellulosic sources such as kenaf, pineapple leaf fiber, banana fiber, coir, paddy straw, sugarcane and much more (J, Yusoh, & W.S, 2015). Mulch from water hyacinth plants is the main ingredient and straw is the fiber material. Leather waste is fiber decomposers and flexibility of organic paper mulch (Khakalo et al., 2014). The basic principle of making organic mulch refers to the process of making synthetic paper. The application of organic paper mulch is expected to be one of the alternatives in dealing with agricultural problems in crop production. The objective of this study is to assess the effect of mulch on the growth and yield of shallots.

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2. Materials and Methods

This research was conducted at the Experimental Farm, Faculty of Agriculture University of Muhammadiyah Malang from March to August 2014. The materials used are water hyacinth, straw, leather waste, water, shallot seed, chicken manure fertilizer, goat manure fertilizer, urea, KNO3, and botanical pesticides.

The experiment method was simple randomized block design (RBD). The treatment of this research is composition of organic mulch sheet materials with 6 treatments and each treatment is repeated three times: A = water hyacinth: Straw: Leather Waste (5: 3: 2), B = water hyacinth: Straw: leather waste (5: 2: 3), C = water hyacinth: Straw: leather waste (6: 3: 1), D = water hyacinth: Straw: leather Waste (6: 2: 2), E = Black Silver Plastic Mulch (BSPM), and F (non mulch).

The observation variables include the length of plants, the number of leaves, fresh weight, dry weight, the number of tuber and tuber diameter. Climate observations include air temperature, soil temperature and light intensity. Physical test of the various composition of organic mulch sheet includes C-organic (%), organic matter (%), tensile strength (N/cm2) and water absorptivity (%).

3. Discussion and Conclusion

Organic paper mulch is made from a mixture of water hyacinth, rice straw and leather waste. Boiling is done to remove any remaining sap and dirt on the material, and the next is pulping process where the amount of water is twice the amount of material in order to make the decomposition process easier. Nasution (2010) explained that before made into a paper, cellulose fiber must be milled in order to be strong, not hairy and porous. Fiber will expand in the water, and the outer layer of the fiber will break, thus expanding the fiber surface in order to improve the bonding between the fibers on the sheet of paper.

The use of organic paper mulch is done on a piece of land that has been treated by putting organic paper mulch over the land and embedding bamboo in the edges. Before planting, planting hole with a diameter of 5 cm is made. The planting of shallot seeds is adjusted by distinguishing the size of tuber for each group.

3.1. The Growth and Yield of Shallot

The average value of shallot growth and yield which is given a treatment using organic paper mulch is presented in Table 1.

Table 1: Test Result on Average Length of Plant (cm), Number of Leaves, Fresh Weight (g), Dry Weight (g), Number of Tuber and Diameter of Tuber (cm) at 40 Dap (Days After Planting)

Treatment	Length of plant	Number of leaves	Fresh weight	Dry weight	Number of tubers	Diameter of Tuber
A (5:3:2)	38.69 ^{a}	49.28 ^{a}	107.50^{b}	31.18^{b}	14.20^{b}	9.00^{c}
B (5:2:3)	35.33 ^{a}	41.83 ^{a}	101.22^{b}	28.36^{b}	10.91^{ab}	7.87^{bc}
C (6:3:1)	38.28 ^{a}	43.00 ^{a}	87.00^{ab}	20.22^{ab}	9.72^{a}	6.36^{ab}
D (6:2:2)	32.85 ^{a}	43.17 ^{a}	75.56^{a}	16.66^{a}	8.89^{a}	5.61^{a}
E (BSPM)	32.95 ^{a}	43.89 ^{a}	67.83^{a}	13.46^{a}	9.17^{a}	5.92^{a}
F (non mulch)	29.93 ^{a}	38.39 ^{a}	45.56^{a}	11.07^{a}	8.39^{a}	5.11^{a}
HSD 5%	13.85	17.92	46.77	21.70	46.77	21.70

Description: Average value with similar letter on the same column shows that it has insignificant difference by 5% according to Tukey Test

Table 1 shows that the length of plant and the number of leaves treated with organic paper mulch with composition A Water Hyacinth: Straw: Waste Leather (5: 3: 2) tends to be higher than those given other treatments. Although the average of length of plant and number of leave was not significantly different between all treatment (non mulch, BSPM and organic mulch sheet). Fresh weight, dry weight, number of tuber and diameter of tuber in organic paper mulch treated with composition A Water Hyacinth: Straw: Leather Waste (5: 3: 2) and B Water Hyacinth: Straw: Leather Waste (5: 2: 3) are significantly different and tend to be higher than those given other treatments.

The result of analysis of variance regarding treatment of organic mulch paper on the length of plant and number of leaves shows an insignificant effect at 40 dap. This is due to the use of undecayed mulch, so organic matter did not add into the soil yet (Sierra, M¨uller, & Trumbore, 2012). Related with previous research, both the paper and polyethylene mulch promoted growth and development of head lettuce as reflected by earlier heading and heavier heads compared with a manually weeded control (Brault, Stewart, & Jenni, 2002a). Organic matter such as mulch can affect plant growth and it can be a provider of nutrients for plants.

Based on the analysis of variance, fresh weight and dry weight have a significant effect. The average value of fresh weight, dry weight, diameter of tuber and number of tuber indicates that treatment A Water Hyacinth: Straw: Leather Waste (5: 3: 2) and treatment B water hyacinth: Straw: Leather Waste (5: 2: 3) have a significant difference and are likely to be higher compared to other treatments. Differ from the previous study that explained all mulch treatments give a better result than the treatment without using mulch, but there is no significant difference in cucumber yield from all types of paper mulches used in the research (Haapala, Palonen, Tamminen, & Ahokas, 2015). It is indicated the various composition of organic mulch sheet has different effect on yield of shallot.

3.2. Climate

Soil temperature shows that organic mulch treatment ranges from 27.1oC to 27.6oC compared to soil temperature in treatment E (BSPM) and F (without mulch). The highest temperature is shown in treatment E (BSPM) while the lowest temperature is in treatment C (6: 3: 1) (Fig 1). It was consistent with the previous study which mentioned that the soil temperature in organic mulch (straw, sawdust, peat and grass) treatment was 7% lower compared to the treatment without using plastic mulch (Sinkevičienė, Jodaugienė, Pupalienė, & Urbonienė, 2009). Soil moisture shows that organic mulch treatment ranges between 57-59%. The highest value of moisture in treatment C is

(6: 3: 1). Meanwhile, the lowest value of moisture is in treatment A (5: 3: 2) (Fig 2). Mulch treatment gave positive impact with increase soil temperature and moisture than bare soil (Yaghi et al., 2013).

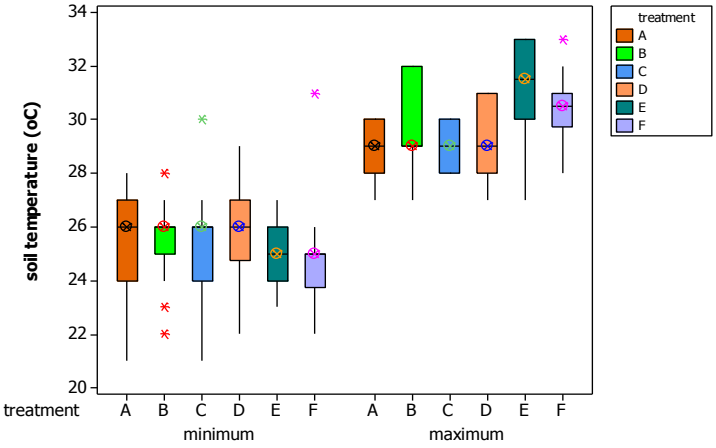


Fig 1: Minimum and Maximum Soil Temperature on the Various Treatment of mulch

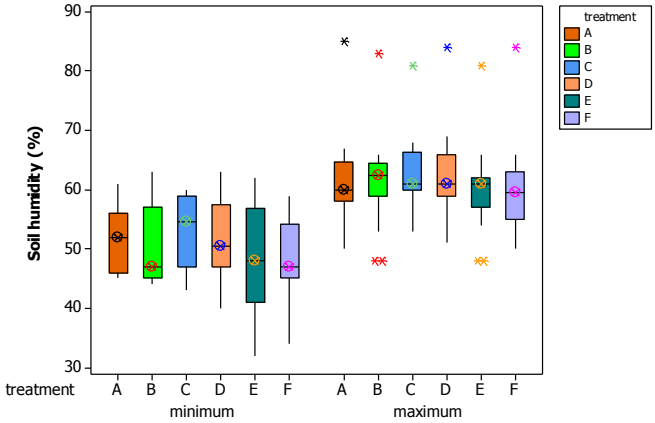


Fig 2: Minimum and Maximum Soil Humidity on the Various Treatment of Mulch

Light intensity is divided into two observation methods, namely received and reflected light. Received light shows that each treatment has the same pattern, but reflected light is different from one another. The highest value of light absorption is treatment C (6: 3: 1), whereas the lowest value of light absorption is treatment F (without mulch) (Fig 3). The percentage of the transmitted and the reflected light on the gray paper mulch treatment is 20% and 25% higher compared to the BSPM treatment (Brault, Stewart, & Jenni, 2002b).

The composition of organic materials can stabilize soil temperature and humidity according to the needs of shallot plant, which requires optimum temperature 27o C and humidity 57%. The growth and yield of shallot were related to the weed control and soil moisture conservation efficiency of the mulches (Mayun, 2007; Woldetsadik, Gertsson, & Ascard, 2003). Results of different kinds of mulching materials under different soil and climatic conditions indicate increased plant growth and yields and improved bulb size of onions. The yield increases of shallot could be attributed to the combined effect of weed control, conservation of soil moisture, and increase in soil temperature. Leaf and bulb growth of onion plants are linearly correlated to temperature from 6 to 27 °C (Woldetsadik et al., 2003). During the development of tuber high-temperature stress happens, the tuber will have abnormal shape due to new growth from the previously formed tuber which is called secondary growth (cracks in the tuber and lengthening of the tip of the tuber). Humidity fluctuation between night and day which varies a lot will reduce the yield. If the night humidity is low, the air temperature will be high, so the plant will do a lot of respiration.

Iriani (2013) states that to be able to photosynthesize properly, plants require high light intensity to extend its branches and increase the width and weight of its leaves. The increasing amount of light which can be received by plants will accelerate the process of tuber formation and flowering time, while excessive light intensity can lower the yield due to high transpiration that can not be compensated by water absorption from the soil. Therefore, the stomata close and the absorption of CO2 is reduced so that the photosynthetic production is also reduced. Based on the observation, light intensity shows that the composition of organic material produces relatively uniform light absorption ranging from 500 to 550 lux compared to treatment E (BSPM), i.e. 400 lux. Light absorption value in treatment F (without mulch) tends to be the lowest (200 lux) when compared to other treatments.

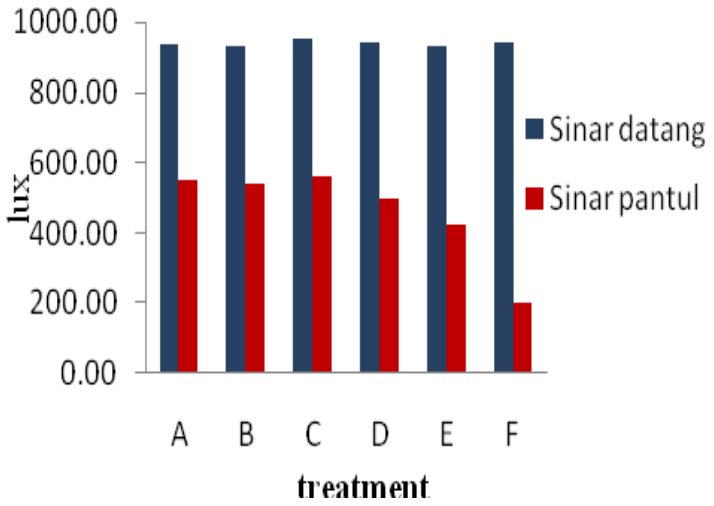


Fig 3: Intensity of the Received and Reflected Light Various Treatment of Mulch

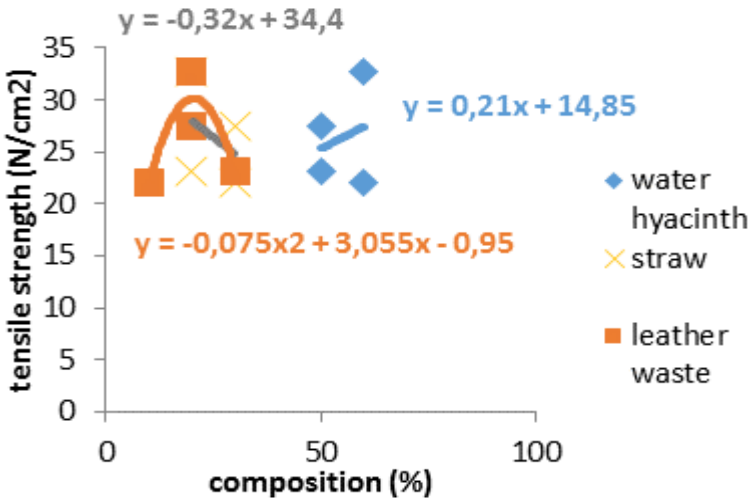


Fig 4: Correlation between composition of mulch and tensile strength

Water hyacinth can be used as mulch in addition to rice straw as fiber and waste leather as material flexibility. Organic paper mulch is a sheet with 100 cm long, 50 cm wide, 0.025 cm thick and weight 25 g. Organic mulch sheet has advantages than inorganic mulch such as the addition of C-organic and organic matter when mulch has decayed. In addition to, organic mulch sheet has high water absorptivity to prevent excess water on the land surface and flooding also reservation soil humidity. Correlation between composition and tensile strength shows the optimal composition use of leather waste is 20%, increasing composition of straw inversely with tensile strength and increasing composition of water hyacinth tended to increase of tensile strength.

Table 2: Physical Test of Various Composition of Organic Mulch Sheet

Treatment	C Organic (%)	Organic Matter (%)	Tensile Strength (N/cm^2)	Water Absorptivity (%)
A (5:3:2)	27.69	47.90	27.5	57
B (5:2:3)	32.35	55.96	23.2	48
C (6:3:1)	32.45	56.14	22.1	62
D (6:2:2)	31.03	53.68	32.8	47

4. Conclusion

The various compositions of organic mulch sheet are better in the growth and yield of shallot than the use of black silver plastic mulch (BSPM) and without mulch. Organic mulch sheet provide stable and appropriate microclimate to support growth and increase yield of shallot. Based on the result, the use of organic paper mulch treatment A Water Hyacinth: Straw: Waste Leather (5: 3: 2) and treatment B Water Hyacinth: Straw: Waste Leather (5: 2: 3) to the generative phase is significantly different than other treatments. Increasing of fresh weight by applying organic mulch sheet and 103,73% more than non mulch and 36,84 % more than black silver plastic mulch. The use of organic mulch sheet also increase number of tuber amount 30,27% more than non mulch and 19,19% more than black silver plastic mulch. Meanwhile, organic paper mulch on the vegetative phase of shallot has an insignificant effect.

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