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GROWTH AND YIELD OF UPLAND RICE BY MULCHING

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Abstract

Upland rice is an alternative rice producer for lowland rice. Mulching is an alternative agronomic technique for increasing upland rice productivity. The purpose of this study is to modify plant media by utilizing mulch to increase growth and yield of upland rice. The study uses factorial randomized block design with three replications. The first factor are upland rice varieties namely Red Sigambiri, IPB 8G and IPB 9G. The second factor are mulches namely Silver Black Plastic Mulch, *Asystasia gangetica* and rice straw. Results show that mulching was able to affect the growth and yield of upland rice, whereby IPB 9G variety was superior compared to Red Sigambiri and IPB 8G. Interaction treatment can only influence the growth of upland rice, specifically the number of productive tillers. The highest number of productive tillers was found in the interaction of IPB 9G with Silver Black Plastic Mulch. Red Sigambiri and 8G IPB varieties produced the highest number of tillers with *A. gangetica* mulch.

Keywords: Upland rice, mulch, growth, yield.

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1. Introduction

Upland rice has been widely cultivated in Indonesia compared to lowland rice. National rice production in 2013 amounted to 70.87 million tons of milled dry grain and has increased by 1.81 million tons (2.62%) when compared to 2012. The increase in the rice production was estimated to occur in Java by 0.87 million tons and outside of Java by 0.94 million tons. Production increase may be due to the increase by 2.41 % (324.39 thousand ha) of harvested area, and 0.19 % (0.10 kw/ha) of productivity (BPS, 2013). However, continuous availability from year to year cannot be ascertained due to the increasingly narrow fertile land and current conditions of climate change.

1.1. Mulching

An effort to overcome the problem in upland rice cultivation is by mulching. In addition to Silver Black Plastic Mulch, mulch can also come from organic materials such as rice straw or weeds that are commonly found on dry land. According to Sutanto (2003), the use of organic matter can improve soil physical, chemical and biological properties so that the health and preservation of land can be well maintained for sustainable agricultural activities.

Mulch is commonly used to cover soil surface around plants to create suitable conditions for growth (Bhardwaj & Yadav, 2012). Mulching can reduce the growth of weeds on land to prevent competition between cultivated plants and weeds. Mulching can also maximize sunlight reception absorbed by plants for optimal growth. Mulching is intended to maintain the microclimate around plants such as temperature and humidity so that plants can grow at an optimum (Multazam, 2014).

2. Problem Statement

Upland rice productivity is lower than lowland rice due to the increasingly narrow fertile land and current climate change conditions.

3. Research Questions

Can mulch increase the growth and yield of upland rice varieties?

4. Purpose of the Study

The purpose of this study is to increase growth and yield of upland rice varieties by modifying the plant media using different kinds of mulch.

5. Research Methods

The study was conducted at the Experimental Farm, Faculty of Agriculture, Islamic University of North Sumatra, Gedung Johor Medan from June 2018 to October 2018.

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5.1. Samples

This study used a Factorial Randomized Block Design (RBD) with three replications. The first factor was upland rice varieties, consisted of three levels : Red Sigambiri (V1), IPB 8G (V2) and IPB 9G (V3). The second factor was mulches consisted of four levels : No Mulch (M0), Silver Black Plastic Mulch (M1), Rice Straw Mulch (M2) and *Asystasia gangetica* Mulch (M3).

5.2. Experiment

Upland rice planting was carried out using seeds previously immersed in Dithane M-45 fungicide solution for 24 hours to prevent leaf rust and imbibition. The seeds were then dried until rice sprouts emerged (± 2 days), and planted in plots measuring 2 m x 2 m with a spacing of 20 cm x 20 cm. Silver black plastic mulch was prepared and installed before the planting; whilst rice straw mulch and *A. gangetica* were placed around the seedlings at 10 days after sowing. To determine the growth and yield of the upland rice varieties, observations were recorded such as the leaf area, number of productive tillers, weight of 1000 rice grains and yield per plot.

6. Findings

6.1. Leaf area (cm^2)

Statistical analysis showed mulching had significant effect on the leaf area of the upland rice varieties. Treatment of varieties and interaction among the treatments however had no significant effect (Table 01).

Table 01. Leaf area (cm^2) of the upland rice varieties treated with different types of mulching

Mulch Type (M)	**Varieties (V)**			**Mean[1]**
	Red Sigambiri (V_1)	IPB 8G (V_2)	IPB 9G (V_3)	
No Mulch (M_0)	104.46	146.14	109.40	120.00 a
Silver Black Plastic (M_1)	97.55	91.77	73.17	87.50 b
A. gangetica (M_2)	96.53	106.75	112.95	105.40 ab
Rice Straw (M_3)	101.46	107.71	93.81	101.00 ab
Mean[1]	100.00	113.09	97.33	

*Note: No letters in the same column and row indicate not significant differences according to Duncan test ($P < 0.05$).
[1]Different letters on the same column and row indicate not significant differences according to Duncan test ($P < 0.05$)

Table 01 shows that the highest leaf area (120.00 cm^2) of upland rice was obtained without any mulching treatment whilst the lowest leaf area (87.50 cm^2) was with Silver Black Plastic Mulch. This was because each plant variety had a different growth response due to internal and external factors. According to Paramaditya, Islami, and Guritno (2017), since leaf is the site for light recipient and photosynthesis, the leaf area is used to determine the photosynthetic rate per unit of plant. Leaf area is a quantitative measure of plant growth and can determine the success of crop yield by the amount of sunlight received.

The different varieties of the upland rice had no significant effect on leaf area. This is because this research was conducted between July and September. Such period has high rainfall and many rainy days.

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Surtinah (2008) mentioned that high rainfall will inhibit photosynthesis and lower the temperature, and the rainfall has very significant effect on crop production. The overall amount of rainfall is important in determining crop yields. Another factor is sunlight, which determines the rate of photosynthesis and from this process carbohydrates will be produced. The more carbohydrates produced through photosynthesis, the higher will be the plant leaf area.

6.2. Number of productive tillers

Statistical analysis showed that mulching, varieties, and interactions among treatments had significant effects on the number of productive tillers (Table 02).

Table 02. Number of productive tillers of the upland rice varieties treated with different types of mulching

Mulch Type (M)	**Varieties (V)**			**Mean[1]**
	Red Sigambiri (V_1)	IPB 8G (V_2)	IPB 9G (V_3)	
No Mulch (M_0)	10.53 fg	9.80 g	12.67 c	11.00 c
Silver Black Plastic (M_1)	8.73 h	11.73 de	14.87 a	11.80 b
A. gangetica (M_2)	12.13 cd	13.93 b	13.53 b	13.20 a
Rice Straw (M_3)	11.20 ef	10.73 f	11.33 def	11.10 c
Mean[1]	10.65 c	11.55 b	13.10 a	

*Note: No letters in the same column and row indicate not significant differences according to Duncan test ($P < 0.05$).
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The highest number of productive tillers (13.20 tillers) was found in the treatment with *A. gangetica* and the lowest was in the treatment without mulching (11.00 tillers). Mulching with *A. gangetica* provided a good source of nutrients for the rice to form plant organs as could be seen in the number of tillers. Rice plants need macronutrients; and *A.gangetica* has supplied the elements of nitrogen phosphorus and potassium (NPK) for the formation of tillers and other organs. According to Asbur, Rambe, Purwaningrum, and Kusbiantoro (2018), the use of *A.gangetica* as soil cover for crops is to increase the nutrient content of NPK in the soil, reduce erosion, increase soil moisture content, increase organic matter content and soil carbon stocks. Hasrizart (2008) stated that photosynthetic ability will affect plant growth to produce more numbers of tillers. According to Nasir (2002), maximum yield will be achieved if a cultivar receives the optimum combinations of water, fertilizer, mulch and other cultivation practices. All of these input factors are important in achieving high productivity.

The highest number of productive tillers was found in IPB 9B variety (13.10 tillers) and the lowest in Red Sigambiri variety (10.65 tillers). Makarim and Suhartatik (2009) found that the growth patterns of tillers in rice are affected by genetic varieties which influenced the number of tillers produced. Abdullah (2004) stated that rice varieties with short stems have many tillers and have the ability to produce more panicles per clump (about 20 panicles per clump) in contrast to the new rice varieties.

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Interaction of IPB 9G variety with Silver Black Plastic Mulch produced the highest mean of productive tillers (Table 02). This is because such variety is superior. According to Simanjuntak, Ginting, and Meiriani (2015), superior varieties are able to provide higher yield quality because they are highly resistant to pests and diseases and could adapt well enough to the environment. The use of Silver Black Plastic Mulch can protect the soil from wind and erosion, thereby reducing root stress symptoms and also plant health deterioration. Kadarso (2008) concluded that the use of Silver Black Plastic Mulch is good for plant growth because the silver colour on the upper surface could reflect the incoming solar radiation and increases photosynthesis. On the other hand, the black colour of the mulch will absorb the solar heat and energy, thus causing almost zero solar radiation to be transmitted to the ground. This causes the soil temperature to remain low and promotes plant growth.

6.3. Weight of 1000 rice grains (g)

Statistical analysis showed that the upland rice varieties had significant effect on the weight of 1000 grains, while mulching and interaction among treatments had no significant effect (Table 03).

Weight of 1000 grains is an indicator of sink strength, namely the ability of the organ sink or the ability of the seeds to attract assimilates from photosynthesis. The greater the strength of the sink, the more it will affect the assimilate proportions. The two main factors that influence sink strength in seeds are cell turgor and hormones (Sumardi, 2010).

Table 03. Weight of 1000 grains (g) of the upland rice varieties treated with different types of mulching

Treatment	**Varieties (V)**			**Average[1)]**
	Red Sigambiri (V_1)	IPB 8G (V_2)	IPB 9G (V_3)	
Mulch Type (M)				
No Mulch (M_0)	33.8	35.46	32.7	11.33
Silver Black Plastic Mulch (M_1)	44.02	35.14	40.0	13.2
A. gangetica Mulch (M_2)	40.56	26.29	38.83	11.7
Rice Straw Mulch (M_3)	34.18	28.71	43.2	11.8
Average[1)]	**12.71 a**	**10.47 b**	**12.89 a**	

*Note: No letters in the same column and row indicate not significant differences according to Duncan test ($P < 0.05$).
[1]Different letters on the same column and row indicate not significant differences according to Duncan test ($P < 0.05$)

The highest weight of 1000 grains was found in IPB 9G varieties (12.89 g), and the lowest was in IPB 8G (10.47 g). Setiobudi, Abdullah, Sembiring, and Wardana (2008) stated that the weight of 1000 grains was determined by genetic traits especially panicle length, panicle branches and grain differentiation. In this study, the high weight of 1000 grains in IPB 9G variety was affected internally by genetics and external derivatives which are the environmental factors such as the soil climate, light and biotic factors. Similarly, Eerens, Lucas, Easton, and White (1998) stated that the external factors could affect plant growth directly or indirectly, especially the light factor which plays a role for seed

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germination, yield weight, seedling growth, differentiation of various tissues and organs, and reproduction.

Mulching had no significant effect on the weight of 1000 grains. This is due to the role of mulch as a microclimate regulator, especially for radiation interception by plants and temperature which did not work well and affected the process of growth and seed filling. All plant metabolic activities are directly affected by temperature variations. Very low temperatures cause injury to plants due to cold and freezing, whilst very high temperatures make plants lacking of water and will stop to grow. In addition, metabolism process needs nutrients.

6.4. Production per plot (g)

Statistical analysis showed that the upland rice varieties had significant effect on production per plot, whilst mulching and interaction among treatments had no significant effects (Table 04).

Table 04. Production per plot (g) of the upland rice varieties treated with different types of mulching

Mulch Type (M)	**Varieties (V)**			**Mean[1]**
	Red Sigambiri (V_1)	IPB 8G (V_2)	IPB 9G (V_3)	
No Mulch (M_0)	370.00	680.00	730.00	593.33
Silver Black Plastic (M_1)	606.67	853.33	1303.33	921.10
A. gangetica (M_2)	506.67	876.67	616.67	666.70
Rice Straw (M_3)	256.67	516.67	1183.33	652.20
Mean[1]	435.00 b	731.67 a	958.33 a	

*Note: No letters in the same column and row indicate not significant differences according to Duncan test ($P < 0.05$).
[1]Different letters on the same column and row indicate not significant differences according to Duncan test ($P < 0.05$)

Mulching had no significant effect on the production per upland rice plot. It was suspected that mulching did not provide the optimal results because organic mulch was not sufficiently decomposed. Thus, the plastic mulch was unable to modify the nutrients and water needed by the rice varieties to grow and develop productively. Nasir (2002) stated that maximum yield will be achieved if a cultivar has achieved the optimum combination response to water, fertilizer, mulch and other cultivation practices. All of these input combinations are important in achieving high productivity.

The different varieties of the upland rice however have significant effects on the production per plot. The highest was found in IPB 9B with 958.33 g whilst the lowest was Red Sigambiri with 435.00 g. This was because the the former is a superior variety and has the potential to produce higher yield. Hatta (2011) stated that the number of productive tillers was related to yield. Better vegetative growth causes higher photosynthetic rate to produce more dry weight which is stored in the filled grains. An effort to increase growth and production is intensification by technological improvements and the use of superior varieties.

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7. Conclusion

Mulching was only able to affect some growth parameters of the upland rice varieties namely leaf area and number of productive tillers. The treatment had no significant effect on upland rice yield. The use of Silver Black Plastic Mulch produced the lowest leaf area compared to *A. Gangetica* and rice straw, but produced the highest number of productive tillers.

The use of different upland rice varieties affected the growth and yield which were the number of productive tillers, weight of 1000 grains and production per plot. Variety IPB 9G produced high yield compared to Red Sigambiri and IPB 8G. On average, the highest weight of 1000 grains was IPB 9G followed by Red Sigambiri and IPB 8G.

Interaction treatment affected the growth of upland rice only on the number of productive tillers. The highest number of productive tillers was found in the interaction of IPB 9G variety and Silver Black Plastic Mulch whereas Red Sigambiri and IPB 8G produced the highest number of productive tillers with *A. gangetica*.

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