

Application Various Types of Mulch on Growth and Yield of two Potatoes (*Solanum Tuberosum* L) Planted in Medium Altitude

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Abstract: This study aimed to found out the effect of treatment combination toward plant height, number of leaf, leaf area, and total dry weight. This study was done by using Split Plot Design consist of 2 factors repeated thrice for each treatment combination. *Main plot* are potatoes (V) used from Germany variety (V₁) and Flowered Granola variety (V₂) and *sub plot* is mulch application (M) consist of 5 applications which are control (no mulch) (M₀), paddy straw application (M₁), Mexican sunflower application (M₂), silver and black plastic mulch application (MPHP) (M₃), black plastic mulch application (M₄). Observed parameters were plant height, number of leaf, leaf area and total dry weight at 4 week after planting, 6 week after planting, 8 week after planting and 10 week after planting. Analysis result showed that treatment combination for varieties and mulch application at 4 and 6 week after planting has effect toward plant height ($p < 0,05$) while at 8 and 10 week after planting did not affect plant height. Treatment combination for varieties and mulch application at 4, 6 and 8 week after planting has effect toward number of leaf ($p < 0,05$) while at 10 week after planting did not affect number of leaf. Treatment combination for varieties and mulch application at 4, 6, 8 and 10 week after planting has effect toward leaf area ($p < 0,05$). Treatment combination for varieties and mulch application at 4, 6, 8 and 10 week after planting has effect toward total dry weight ($p < 0,05$).

Keywords: *Solanum tuberosum* L, plant height, number of leaf, leaf area, total dry weight, Split Plot Design.

INTRODUCTION

Potato (*Solanum tuberosum* L) is a plant from *Solanaceae* family. As one of the food ingredients, it was prioritized in its development since potato has strong competitiveness compared to other vegetables. Role of potato in Indonesia has increase, either as fresh produce and processed product. Position for potato in the future was expected to be utilizing as vegetables and also to become option for carbohydrate diversification in order to strengthened food security.

In Indonesia, potato cultivation was mostly done in high altitude (1000-3000 m asl), with potato production centers were West Java, Central Java, East Java, South Sulawesi, North Sumatra, West Sumatra, and Jambi. Generally speaking, potato production in Indonesia was still quite low, about 16.2 ton. ha⁻¹ [1]. Production of potato in subtropical nations could reach 37.8 ton. ha⁻¹ [13]. Effort to improve potato production could be done through intensification and extensification at appropriate soil. Strategy used in efforts to improve potato cultivation would be by developing cultivation to lower land, which is at medium altitude (300-700 m asl) which quite vast in

Indonesia. Potato cultivation area in 2013 was 62.900 ha and total production reach 1.023.381 ton or average productivity 16,27 ton ha⁻¹ [2].

Potato development in medium altitude nowadays still faces several obstacles. One of its main obstacles is that there was no potato cultivars appropriate for the environment, particularly regarding temperature and humidity. Therefore, new cultivars appropriate to medium altitude should be found, those with high temperature and low humidity trait. One of the main problems was the inability of cultivars to cope with environmental stress thus has a very low yield [3, 4]. Regarding these matters, environmental changes should be done to create an optimum growth condition for potato to reach its potential value. BPS data [1] showed the increase of new cultivation area in 2011-2012 about 10.20% compare to productivity increase which was only 0,42%.

Extensification in planting area should be done in area with altitude of < 1000 m asl. To reduce the impact, Basuki and Kusmana [5] report that potato cultivation in medium altitude has yield potential of

21.44 ton/ha, better than current average national potato production which only 16.58 ton/ha. In reality, average productivity of potato in medium altitude was quite low (about 17.58 ton ha⁻¹) (Balai Pengkajian Teknologi Pertanian Yogyakarta [6]. According to Ashandhi and Gunadi [1], regions with maximum air temperature 30°C and minimum air temperature 15°C would be very good for potato cultivation than regions with relatively constant air temperature of 24°C. In subtropical areas and in tropical areas of high altitude, tuber formation would occur at day temperature of 25°C and night temperature of 17°C or lower. Good soil temperature for tuber growth would be between 14.9 to 17.7 [7].

This opinion was in line with result of study conducted by Wardiyati [8] which conducted toward three varieties in different temperatures, and its result showed that Red Pontiac variety has higher tuber weight (126 gram) compare to Sebago variety weight (105 gram).

MATERIALS AND METHODS

The research was conducted on July to October 2017, located at Dadap Rejo Areng-areng, Batu sub district of Batu City. The experiment land at the 600m asl, average temperature of 26°C, air humidity 85%, soil type is Andosol, acidity level of 5.5-6, rainfall +2000 mm/year.

The tools used in the research are mattock, harrow, sickle/chopping knife, stake rope, meter, scissors, cutter, hand sprayer, scale, ruler, camera, thermometer, soil moisture tester and writing tools.

Materials used in the research are Germany and Granola Kembang potato seeds with weight of ± 30-50 g/seed, paddy straw, paitan plants, silver black plastic, black plastic.

The research was done with Split Plot Design, consist of two factors which is replicated 3 times for each treatment combination. Main plot is potato plant variety (V), that is Germany variety (V1) and Granola Kembang variety (V2), and subplot is mulch application (M) which consist of 5 application types, that is control (without mulch) (M0), paddy straw application (M1), paitan plants application (M2), silver black plastic mulch (MPHP) (M3), black plastic mulch application (M4). Parameters observed are plant height, leave amount, leave weight, total dry weight at 4 mst, 6mst, 8mst, and 10 mst old.

RESULTS AND DISCUSSION

Plant Height

Variation analysis result showed that there was interaction between mulch treatment and potato varieties toward plant height at 4 and 6 week after planting, while in 8 and 10 week after planting there was no interaction but main plot and sub ploton. Has significant effect toward plant height. Both main varieties and mulch of sub ploton. Has higher plant height than those without mulch. Table 1 shows the details. In 4 and 6 week after planting, mulch treatment resulting higher plant compare to those without mulch. Average plant height of two potato varieties in various mulch applications was shown in Table 1. Interaction between type of mulch and potato varieties concerning plant’s height.

Table-1: Average Plant Height (cm²) of Two Potato Varieties with treatment of various mulch applications

Plant’s Age (week after planting)	Varieties		
	Mulch	Germany	Flowered Granola
4	Without mulch	28.00 ^a	34.00 ^{cd}
	Straw	33.33 ^{bc}	35.67 ^{ef}
	Mexican sunflower	32.00 ^b	35.33 ^{de}
	PHP	33.33 ^{bc}	37.00 ^f
	Black plastic	32.33 ^b	36.00 ^{ef}
	BNT 5%	1.43	
6	Without mulch	39.33 ^a	41.67 ^{ab}
	Straw	42.33 ^b	52.33 ^d
	Mexican sunflower	40.67 ^{ab}	47.33 ^c
	PHP	45.33 ^c	58.67 ^e
	Black plastic	41.67 ^{ab}	52.67 ^d
	BNT 5%	2.78	

Notes: Number accompanied by the same letter in one column and row show insignificant value based on BNT test in 5% rate; ns=insignificant; PHP=Silver Black Plastic.

Average plant height in Table 1, for 4 week after planting showed that plant height was affected by variety. As shown in interaction observation between varieties and mulch application, mulch application resulting higher plant height than those without mulch in both varieties tested in the beginning of 4 week after planting. Both varieties within various mulch

applications generally have relatively high plant height compare to those without mulch application. In 4 and 8 week after planting, plant without mulch has no difference in plant height compare to those treated with mulch application while those with mulch application has difference in plant height.

Observation in 6 week after planting for both varieties resulting higher plant height in silver and black plastic mulch compare to no mulch, and other mulch application. In other mulch application or black plastic mulch, straw also resulting higher plant height compare to those without mulch for both varieties tested.

Variation analysis result showed that in 8 and 10 week after planting there was no interaction between both varieties with mulch application regarding plant height. Effect survive from its natural enemy, producing, or its surrounding changes.

According to Jumin [9] environmental changes such as those in temperature, humidity, sun radiation, and wind would create short term responses, however, when it occurs continuously in one or more period of plant's growth, it would gradually change plant's physiology. This difference in appearance would more likely cause by genetic factors which have different effect toward mulch combination, in which plants would able to utilize the effective growth environment. This would support the photosynthesis process to run well thus photosyntat would be translocated to all

vegetative parts of the plant thus increase cells numbers and propagate and increase the size of this parts particularly meristematic part. This was supported by Harjadi [10] who suggest that when a plant forms new cells, cells elongation would develop the stem, leaf and its root system.

Number of leaf

Variation analysis result showed that there was interaction between various mulch treatments and varieties of potato toward number of leaf in 4, 6 and 8 while in 10 week after planting there was no interaction, however, main plot and sub ploton. Has significant effect toward number of leaf. In both varieties and mulch application, sub-plot plants have more number of leaf compare to those without mulch application. Table 2 shows some details. In 4, 6 and 8 week after planting, mulch application has higher number of leaf compare to those without mulch application. Observation. Average number of leaf for two potato varieties with mulch application was displayed in Table 2. Interaction between mulch treatment and potato variety concerning number of leaf. Number of leaf for two potato varieties related to mulch treatment was displayed in Table 2.

Table-2: Average number of leaf (cm²) for two potato varieties related to mulch treatment

Plant's Age (week after planting)	Varieties		
	Mulch	Germany	Flowered Granola
4	Without mulch	12.00 ^a	12.33 ^{ab}
	Straw	13.33 ^{bcd}	13.67 ^{cde}
	Mexican sunflower	12.67 ^{abc}	14.67 ^{ef}
	PHP	14.00 ^{def}	13.33 ^{bcd}
	Black plastic	14.33 ^{ab}	15.00 ^f
	BNT 5%	1.07	
6	Without mulch	15.67 ^a	19.00 ^{bc}
	Straw	22.33 ^f	19.33 ^{cd}
	Mexican sunflower	16.86 ^a	17.33 ^{ab}
	PHP	22.00 ^{ef}	20.33 ^{cde}
	Black plastic	21.00 ^{def}	24.33 ^g
	BNT 5%	2.77	
8	Without mulch	21.67 ^a	22.67 ^a
	Straw	26.33 ^{bcd}	24.67 ^b
	Mexican sunflower	24.67 ^b	27.67 ^d
	PHP	25.00 ^{bc}	26.67 ^{cd}

Notes: Number accompanied by the same letter in one column and row show insignificant value based on BNT test in 5% rate; ns=insignificant; PHP=Silver Black Plastic.

Harjadi [10] suggest that changes in concentration of growth regulation substance were not always related with its actual response. Growth regulation substance did not work alone to create a response, but it was due to interaction from several compound. Growth regulation substance is a chemical substance with on or off signal to create events within cells and produce physiology. Combination of Germany variety with black plastic still obtains highest value regarding number of leaf (Table 2). Increasing number of leaf did not apart from the activity of cells elongation which stimulates leaf formation as photosynthesis organ. Age of leaf (leaf development stadium) would

affect the rate and photosynthesis process within the leaf. More leaf to conduct photosynthesis would produce more photosyntat [11]. It was assumed that mulch could modify temperature surrounding the plants so that it could grow well, and create sufficient environment condition to increase number of leaf. According to Ferdous *et al.* [12, 4], suggesting the benefit of mulch, it would increase yield in quantity and quality also increase water use efficiency. Mulch was highly effective in increasing top soil layer in the beginning of planting season when the temperature was low in spring [6]. Variety cultivated in medium altitude has the ability to adapt to the surrounding environment.

Table-3: Total dry weight (g plant⁻¹) of two potato varieties with various mulch applications

Plant's Age (week after planting)	Varieties		
	Mulch	Germany	Flowered Granola
4	Without mulch	2.07 ^a	1.63
	Straw	3.30 ^{bc}	4.33
	Mexican sunflower	2.77 ^b	4.43
	PHP	3.43 ^c	5.27
	Black plastic	4.51 ^d	6.73
	BNT 5%	0.61	
6	Without mulch	3.43 ^a	3.73 ^a
	Straw	6.94 ^{cd}	7.75 ^e
	Mexican sunflower	6.25 ^{bc}	6.62 ^c
	PHP	7.75 ^e	7.58 ^e
	Black plastic	7.18 ^d	6.75 ^c
	BNT 5%	0.34	
8	Without mulch	4.60 ^a	8.17 ^c
	Straw	8.61 ^{cd}	8.36 ^c
	Mexican sunflower	10.28 ^e	7.33 ^b
	PHP	12.58 ^f	10.08 ^e
	Black plastic	12.21 ^f	9.14 ^d
	BNT 5%	0.74	
10	Without mulch	5.21 ^a	6.16 ^b
	Straw	9.18 ^c	10.52 ^d
	Mexican sunflower	11.22 ^{ef}	10.42 ^d
	PHP	11.95 ^g	11.43 ^f
	Black plastic	10.96 ^e	8.97 ^c
	BNT 5%	0.41	

Notes: Number accompanied by the same letter in one column and row show insignificant value based on BNT test in 5% rate; ns=insignificant; PHP=Silver Black Plastic.

Variation test result showed significant effect between differences of two varieties concerning total dry weight of potato in 4, 6, 8 and 10 week after planting. There was interaction between varieties and mulch and showed that mulch treatment resulting higher total dry weight compare to without mulch treatment in both varieties. Result was significant in 8 and 10 week after planting. Mulch treatment showed significant effect compare to control in 4, 6, 8 and 10 week after planting. Average total dry weight was shown in Table 6 above.

In total dry weight observation during 4 week after planting, Granola variety in black plastic mulch treatment with 6.73 gram was much heavier than control with 1.63 g. Combination treatment of mexican sunflower mulch and paddy straw mulch resulting 4.33 gram and 4.43 gram total dry weight and more significant than plant biomass such as root, leaf and stem would be increasing in number. Dry weight was the accumulation of carbohydrate, protein and vitamin also other organic matter [14]. This was supported by study result of Bukit [15] who suggest that larger tuber used would increase plant height, number of stem, and number of leaf, number of tuber and fresh weight of tuber in each clump.

CONCLUSION

Combination of variety with mulch has influence toward plant height, number of leaf, in which

Granola variety showed highest value in silver and black plastic mulch with 37.00, 58.67 while highest value for number of leaf was obtain in black plastic mulch treatment with 15 and 24.33 leaves.

Total dry weight for Germany variety has the highest value in 6-10 week after planting, using silver and black plastic mulch with 7.75 g, 12.58 g and 11.95 g, respectively. Straw mulch and Mexican sunflower mulch could increase plant height, number of leaf and total dry weight.

There was interaction between potato and mulch concerning total dry weight in 4-10 week after planting. We can use Germany and Flowered Granola varieties to be cultivated in medium altitude because both varieties were tolerant toward high temperature.

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