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Effectivity of Mulches and Organic Matter as an Effort of Potatoes to Adapt With Climatic Changes

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Abstract

This research aims to find out the efectiveness of mulches and organic matter as an effort of potatoes to adapt with climatic changes. Research was conducted in farming land in 4 different altitudes (1300, 1500, 1700, 1900) meter above sea level. The experimental design was Split Plot design, applied in each location. Being the main field is mulch types (BPS and straw mulch) and the sub plot is organic matter (chicken manure and compost), applied using the dosages of 10 t/ha, 20 t/ha and 30 t/ha. Each treatment was repeated 3 times. Observation was done starting from 35 days of age from plantation to harvest time in a-10-day interval. Variables of the measured growth include: the height of plants, the number of leafs, the leaf area, plant dry weight, the number of tubers per plant and the weight of fresh tubers per hectares. The result shows that the growth and production of potatoes in 4 different sites show the same pattern. The highest growth and production was obtained in Tulungrejo (1300 meters above sea level). Treatment of Black Plastic Silver (BPS) mulch and compost give the highest growth and production in 4 locations.

Keywords: Climatic change, mulch, BPS

1. Introduction

Climatic change is a condition that people find it hard to cope with in which its impact is greatly felt in various life aspects. Agricultural field is the most susciptible to the impact of climatic change (Yao, Y.-B. et al., 2010). In Indonesia, the impact of climatic changes on agricultural field has greatly been felt especially when dealth with national food security, one of which is potato, one of the food commodities that is one of carbohydrate source diversification. National productivity of potatoes currently still reaches 16 ton/ha, while the potentially average production of Granola varieties that farmers cultivate much accounts for 40 ton/ha.

Most of potato land areas is dominantly located in Batu, situated in high land, a very strategic area as it has several functions such as protecting, production and hidrological functions. High land is highly susceptible to erosion and critical land. High land has also an impact on the function of watershed as it is a water catching limit in raining season and to store water in dry season. This consequently determines the function due to its land biophysical condition (Tingem Munang and Mike Rivington, 2009).

Mismanagement and misuse of processing and utilizing land resources in mountainous areas can result in damage or biophysical threat in the form of degrading land fertility (Müller, et al ,2010; Yao, Y.-B. et al., 2010). Therefore, in order to give abundantly beneficial economic and environmental benefits to community, mountainous areas need the optimal management using technological aspect so that its intensity and erossion frequency as well as degrading mountainous areas can be greatly reduced as the implementation of Good Agricultural Practices (Qin, S. et al, 2011; Raviv, M., et al, 2004). In relation to that condition, the optimal growing environmental management for potato plantation needs to be done, allowing its productivity to go synergically with its potency.

Related to the previous illustration in an effort to adapt with climatic change and to increase land health, research was conducted which aims to find out the effectiveness the use of mulches and the organic matter on potato production in every class of land suitability.

2. Research Method

Research was conducted in Bumiaji district in Batu town, East Java in 4 attitude areas which made up 1300,

1500,1700 and 1800 meters above sea level. Experiment was done from February to June 2012.

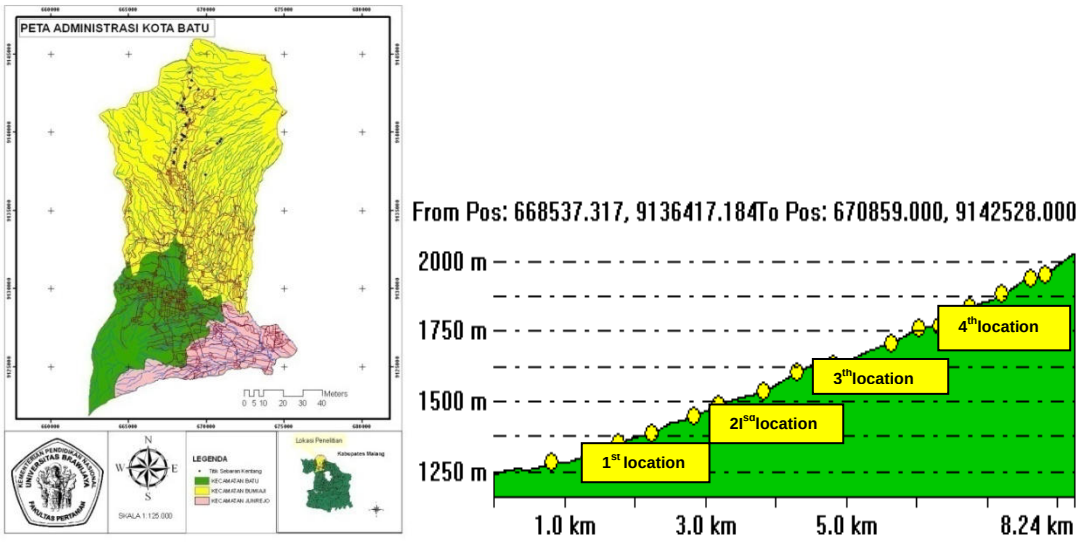


Figure 1. Research Sites in 4 Different Altitudes

2.1. Materials

Materials used in this research were potato with Granola variety, fertilizer, compost, BPS mulch, straw mulch, UREA (45%), SP36 (36% P_2O_5) and KCl (56% K_2O), insecticide, fungicide, APSA-800 WSC, Curacron 500 EC.

2.2. Research Method

It was conducted in farming land in 4 different latitudes. Research conducted in each location used Split Plot Design. The environmental design used was randomized complete block design, each treatment was repeated 3 times. Treatment for each location is depicted as follows: Being the main field is 3 levels of mulches (M0 = mulchless; M1 = straw mulch; M2 = black plastic silver (BPS) mulch. Being a sub-field is a combination of types and dosages. Organic matter: O1D1 = chicken manure fertilizer 10 ton/ha, O1D2 = chicken manure fertilizer 20 ton/ha, O1D3 = chicken manure fertilizer 30 ton/ha, O2 D1 = vegetable waste compost 10 ton/ha, O2 D2 = vegetable waste compost 20 ton/ha, O2 D3 = vegetable waste compost 30 ton/ha. Combination of treatment amounted 18, each of which was repeated 3 times, resulting in the number of trial units 54 units.

Observation was done to sample plants starting from the age of 35 days after cultivation to harvest time having a10-day-interval. The observed growth variables are plant height, number of leaf, leaf area, dry weight of plants, tuber number per plant, fresh tuber weight per hectare. Descriptive statistics and Manova model (multivariate analysis of variance) was used to analyze data of observation result.

3. Result and Discussion

3.1. Soil Temperature

Soil temparature in the researched site had been measured for 92 days of observatory time. It was measured in each location site in both morning and day light hour time. The following is soil temperature's decription in each research location as well as its observatory time:

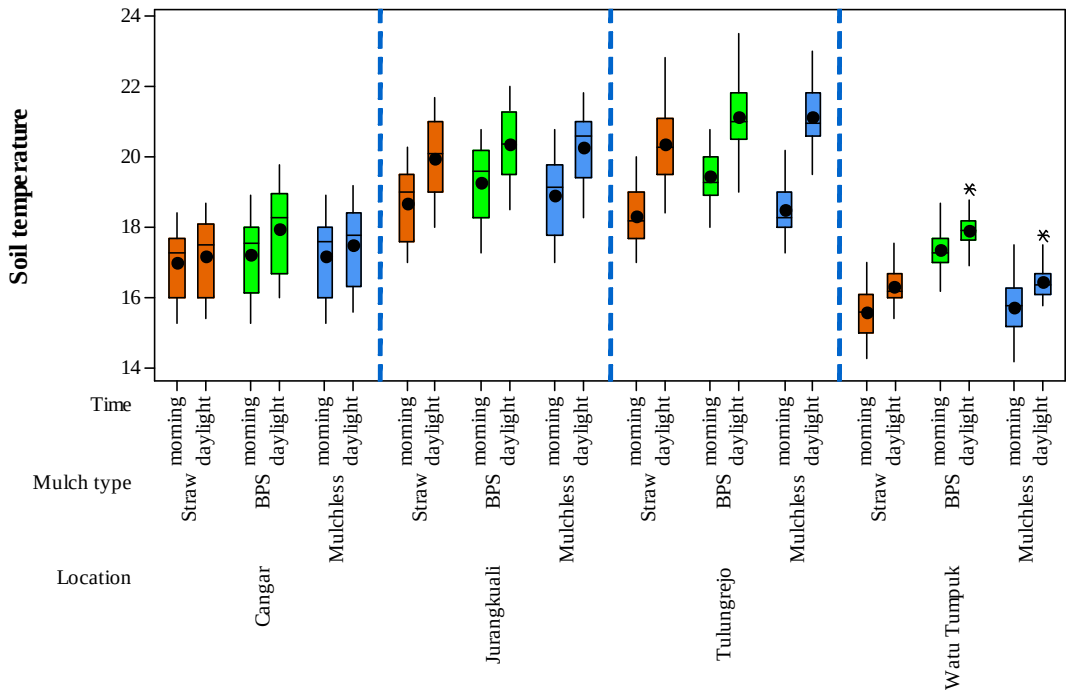


Figure 2. Soil Temperature in Various Treatments in 4 Different Locations

Soil temperature's analysis result illustrated with boxplot diagram in figure 2. above depicts that the use of straw mulch results in a relatively lower soil temperature than the other type of mulches, either in the morning or day light time. The highest soil temperature was shown in the use of BPS mulches, either in morning or day time.

To test soil temperature difference in each location and type of mulches, test using ANOVA was performed. Result of various analysis toward soil temperature indicated the real impact on all treatments of mulch types in various locations and different observatory time. Seen from measurement time, there was a significant difference of soil temperature between morning and day time. As a result, from this test it can be concluded that soil temperature difference occurs due to location factor, mulch type and observatory time

Table 1. Average Soil Temperature in 4 Locations

Location	Soil temperature (^{0}C)	
Watu Tumpuk	16.56	a
Cangar	17.34	b
Jurangkuali	19.58	c
Tulungrejo	19.82	d

Note: The mean value accompanied with the same letter which shows not significantly different based on LSD test (α = 0,05)

The value of the average soil temperature in 4 locations, tested with LSD. From 5% LSD test result it can be explained that there was a significant soil temperature in each research location. Watu Tumpuk area has the lowest soil temperature while Tulungrejo area has the highest soil temperature.

Table 2. The Average Soil Temperature in Various Mulch Treatments

Mulch	Soil temperature (^{0}C)	
Straw	17.92	a
Muschless	18.22	b
BPS	18.84	c

Note: Mean value accompanied with the same letters shows not significantly different based on LSD test result (α = 0,05)

Based on LSD test result, it can then be explained that there was a significant difference of soil temperature in each mulsh type. Straw mulch has the lowest soil temperature while BPS mulch has the highest soil temperature.

3.2. Solar Radiation

The observed solar radiation is the radiation coming on the soil surface and the reflected radiation by soil surface. Solar Radiation was measured in the morning and day time. The following is the description of radiation on plants:

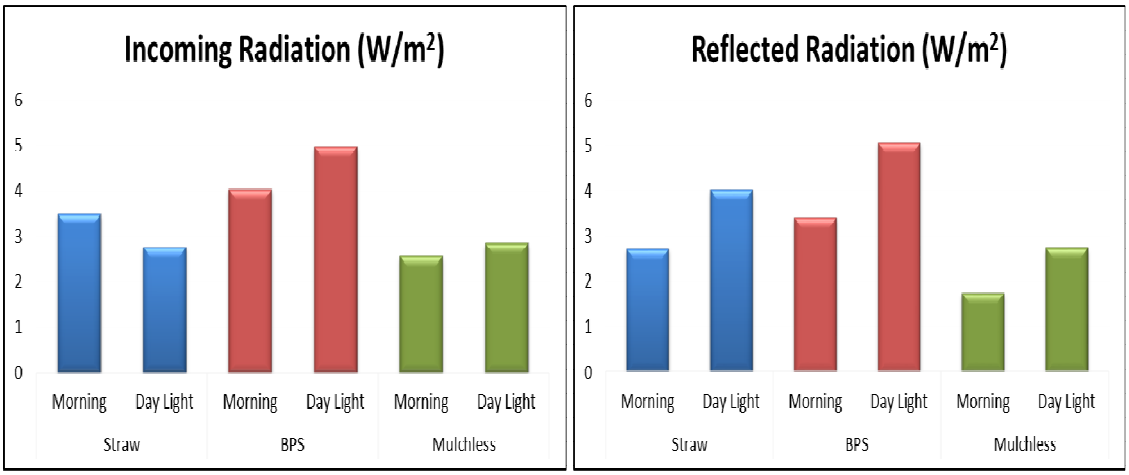


Figure 3 The Accepted and Reflected Radiation by Soil Surface in Mulch Treatment

Based on the given graph, there was a difference of the incoming radiation in various mulches as well as the observatory time. In BPS mulch, the measured radiation of morning time and day time had the highest average while the lowest one was shown by treatment without mulch during morning time. In the graph of measuring the reflected radiation, it can then be explained that the average of the highest reflected radiation was shown in BPS mulch treatment, especially in day light time while the average of the lowest reflected radiation is depicted in the treatment without mulches in morning time.

Table 3. The Average Incoming Radiation in Various Mulches in Both Morning and Day Light Time

Treatment	Incoming radiation (W/m^2)	
	Morning	Day light
Mulchless	2.573 a	2.858 ab
Straw	3.505 bc	2.776 ab
BPS	4.052 c	4.984 d

Note: Mean value accompanied with the same letter shows significantly not different based on LSD test ($\alpha = 0,05$)

To test different radiation to each type of mulches, statistical examination using analysis of variance was used. Test result of incoming radiation shows that there was a noticable effect of radiation on various mulches which were measured in different time. Furthermore, the mean value of test indicates that there was a significant difference as shown in Table 3. The average lowest incoming radiation of treatment without mulch occurs in morning time but not different significantly in straw mulch in day light time. The average incoming radiation which is the highest was shown by BPS mulch in day time..

The result of various analysis on reflected radiation shows that there is a noticable interaction between mulch types during the experiment and observatory time. Then the mean test result of reflected radiation using LSD test is depicted in Table 4.

Table 4. Mean of Reflected Radiation in Various Mulches in Both Morning and Day Light Time.

Treatment	Reflected radiation	
	Morning	Day light
Mulchless	1.753 a	2.749 b
Straw	2.735 b	4.026 c
BPS	3.424 bc	5.086 d

Note: Mean value accompanied with the same letter that shows significantly not different based on LSD Test (α = 0,05)

From the Table of 5% LSD test, the average of the lowest reflected radiation of mulchless treatment occurs in the morning time. The average highest reflected radiation is shown by BPS mulch in day light time.

3.3. Potato growth

The measured growth included plant height, leaf number, leaf width and dry weight of plants. Measuring plant growth was done in 35 hst, 45 hst, 55 hst and 65 hst. MANOVA was used to test mulching use effect, organic matter, and dosage on potato growth was used and dosage of plant growth was done in a multivariate using MANOVA. The following is MANOVA test result in each research site :

Table 5. p-value of Potato Growth in The Treatment of Mulch Types, Organic Matter and its Interaction

Treatment	Location			
	Tulungrejo	Jurang Kuali	Cangar	Watutumpuk
Mulch (M)	0,001	0,027	0,020	0,006
Organic matter (O)	0,000	0,000	0,000	0,000
M*O	0,005	0,265	0,032	0,498

Note: P-value was calculated based on F test statistics which is a conversion of Wilk's Lambda of MANOVA model

Test result of MANOVA can be illustrated that mulch use gives a significant impact on potato growth cultivated in all locations. The use of mulches gives a significant impact on potato growth cultivated in all researched locations. This can be noted from p-value less than α = 0,05. To know the further effect of mulch use, T2 Hotteling was used. The following is the test result of mulch use effect on potato growth in each cultivation sites

Table 6. P-value Rate of Comparation Test of Mean Vector of Growth Variables on Mulch Treatment

Treatment	Location			
	Tulungrejo	Jurang Kuali	Cangar	Watutumpuk
Mulchless vs Straw	0,000	0,011	0,025	0,000
Mulchless vs BPS	0,002	0,000	0,000	0,000
Straw vs BPS	0,004	0,000	0,000	0,000

Note: P-value was calculated based on F test statistics which is a conversion of T2 Hotteling of MANOVA model

Multiple comparison between treatments in a multivariate analysis, using T2 Hotteling test shows that Mulchless gives a significant effect of Straw and BPS mulch on potato growth. Straw mulch then also gives a significant impact on BPS. It can then be concluded that different mulch has an influence on potato growth during observation. Then, factor of organic matter use and dosage (OD) in 4 research sites, p-value was obtained, which is less than α = 0,05. This indicates that there is a significant effect of organic matter use and dosage on potato growth in all locations. The following is the test of organic matter use effect and the further dosage using T2 Hotteling test.

Table 7. P-value Rate of Comparative Test Of Mean Vector of Growth Variables of Organic Matter Treatment

Treatment	Location			
	Tulungrejo	Jurang Kuali	Cangar	Watutumpuk
O1D1 vs O1D2	0,008	0,045	0,002	0,096
O1D1 vs O1D3	0,000	0,001	0,000	0,001
O1D1 vs O2D1	0,022	0,045	0,000	0,053
O1D1 vs O2D2	0,004	0,000	0,001	0,004
O1D1 vs O2D3	0,000	0,000	0,059	0,000
O1D2 vs O1D3	0,025	0,027	0,000	0,043
O1D2 vs O2D1	0,005	0,145	0,013	0,487
O1D2 vs O2D2	0,622	0,040	0,066	0,111
O1D2 vs O2D3	0,000	0,000	0,000	0,029
O1D3 vs O2D1	0,000	0,316	0,025	0,011
O1D3 vs O2D2	0,038	0,116	0,002	0,016
O1D3 vs O2D3	0,001	0,000	0,000	0,093
O2D1 vs O2D2	0,001	0,042	0,375	0,295
O2D1 vs O2D3	0,000	0,000	0,000	0,011
O2D2 vs O2D3	0,000	0,000	0,000	0,009

Note: P-value was calculated based on F test statistics which is a conversion of T2 Hotteling in MANOVA model

From the test result above, it is clear that almost all multiple comparison produces significant differences in all research sites that indicates that organic matter with various dosages give significant effects on potato growth in all sites.

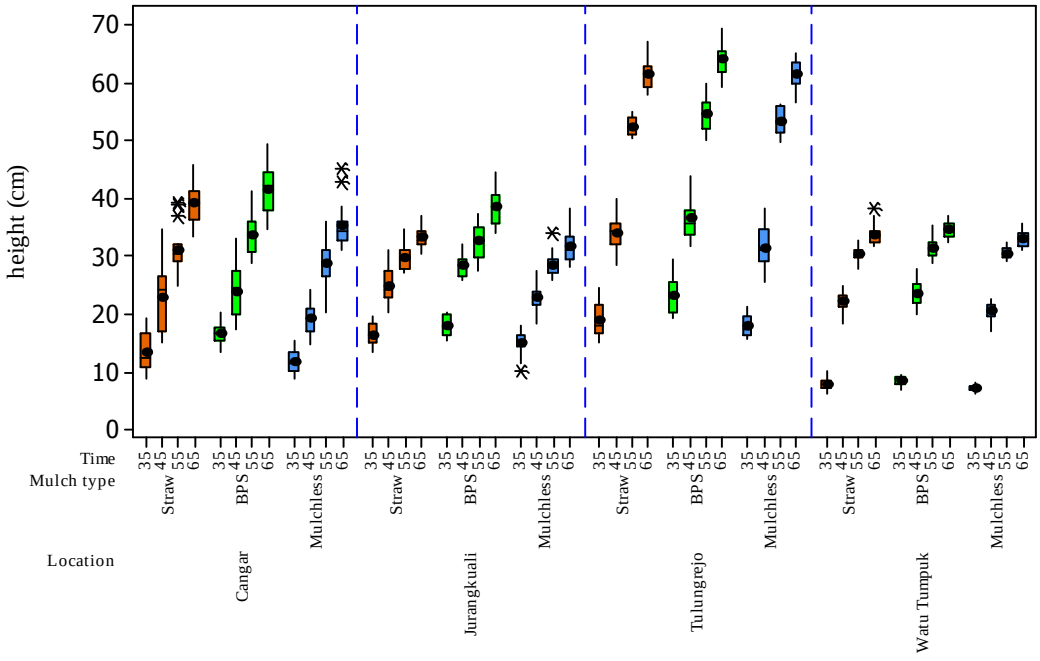
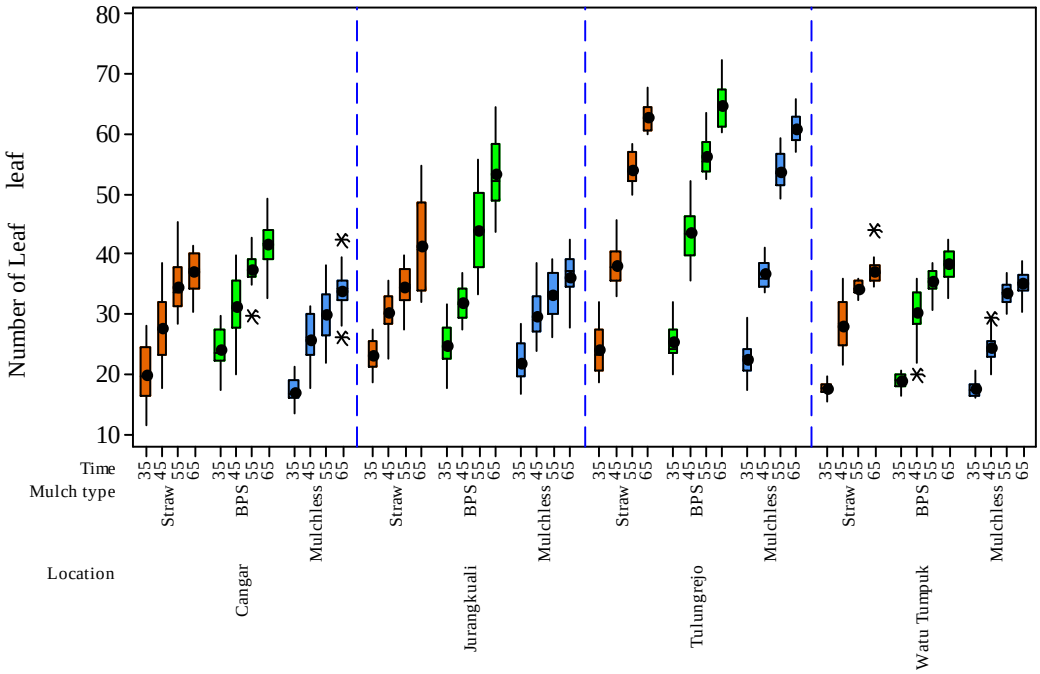


Figure 4. Potato Height in Various Mulch Uses in 4 Altitudes



Figur 5. Number of Leaf in Various Mulch Uses in 4 Altitudes

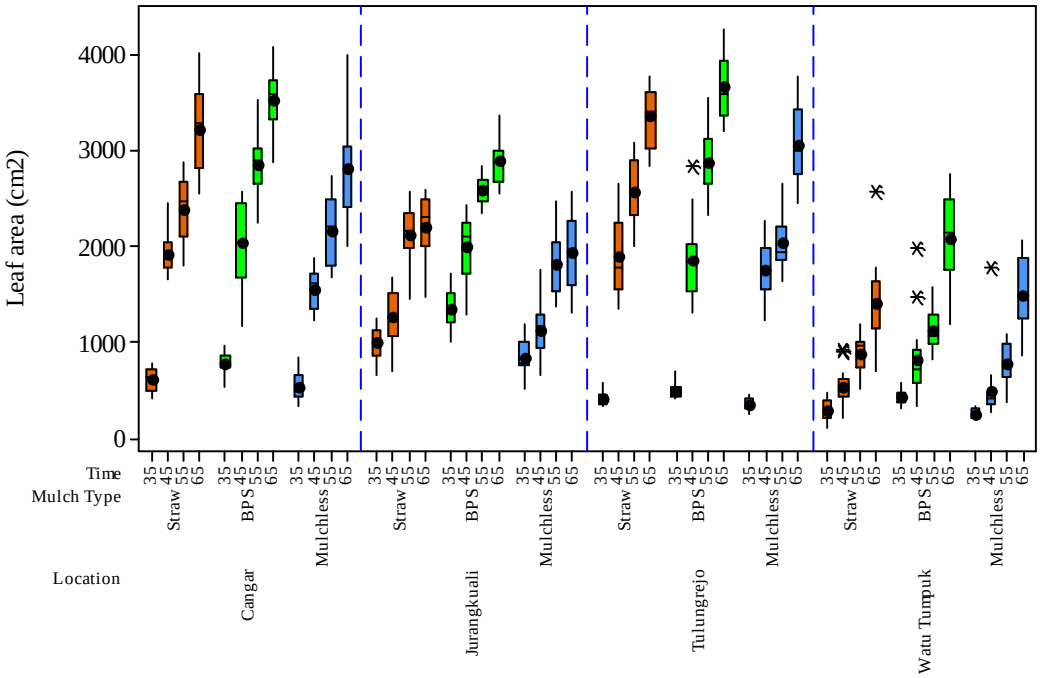


Figure 6. Leaf Area of Potatoes in Various Mulches in 4 Altitudes

3.4. Potatoes Harvest

The measured potato harvest includes harvest result (ton/ha) and number of tubers. Test of mulch use effect, organic matter and dosage on potato harvest were analyzed in a multivariate way using MANOVA. The following is the test result in each sites:

Table 8. p-value Rate of Respond of Potato Harvest Resulto on The Treatment of Mulch Types, Organic Matter and its Interaction

Treatment	Location			
	Tulungrejo	Jurang Kuali	Cangar	Watutumpuk
Mulch (M)	0,024	0,018	0,006	0,006
Organic matter (O)	0,000	0,001	0,027	0,002
M*O	0,001	0,003	0,792	0,157

Note: P-value is calsulated based on F test statistics which is a conversion of Wilk's Lambda in MANOVA model

The test result which used MANOVA depicts that mulsh uses give a significant impact on harvest of potatoes in all locations (p-value less than $\alpha = 0,05$). It can then be concluded that the use of mulches give a significant effect on potato yields. To know the the different mulch types, test of T2 Hotteling was used which is depicted below:

Table 9. P-value Rate of Comparative Test of Yield Production Mean Vectors in Mulch Treatment

Treatment	Location			
	Tulungrejo	Jurang Kuali	Cangar	Watutumpuk
Mulchless vs Straw	0,000	0,000	0,000	0,000
Mulchless vs BPS	0,000	0,000	0,000	0,000
Straw vs BPS	0,000	0,000	0,000	0,000

Note: P-value is calculated based on F test statistics which is a conversion of T2 Hotteling in MANOVA model

Test of multiple comparison in a multivariate analysis using T2 Hotteling test indicates that mulch treatment (Straw and BPS) shows a significant impact compared to Mulchless on harvest production. Straw mulch also shows a significant impact on BPS mulch. It can then be concluded that the use of mulches gives a better yield than that without mulch. Then the added organic matter of several dosages (OD) also shows a significant impact on potato yields in all locations (p-value less than $\alpha = 0,05$) in all locations.

Table 10. P-value of Comparative Test of Yield Production Mean-Value Vectors in The Treatment of Organic Matter

Treatment	Location			
	Tulungrejo	Jurang Kuali	Cangar	Watutumpuk
O1D1 vs O1D2	0,004	0,133	0,158	0,392
O1D1 vs O1D3	0,000	0,010	0,025	0,135
O1D1 vs O2D1	0,003	0,292	0,228	0,557
O1D1 vs O2D2	0,000	0,574	0,077	0,010
O1D1 vs O2D3	0,000	0,004	0,121	0,038
O1D2 vs O1D3	0,010	0,018	0,078	0,042
O1D2 vs O2D1	0,721	0,035	0,035	0,275
O1D2 vs O2D2	0,005	0,024	0,042	0,011
O1D2 vs O2D3	0,003	0,000	0,039	0,029
O1D3 vs O2D1	0,005	0,009	0,065	0,707
O1D3 vs O2D2	0,488	0,001	0,050	0,013
O1D3 vs O2D3	0,004	0,000	0,129	0,049
O2D1 vs O2D2	0,008	0,416	0,469	0,024
O2D1 vs O2D3	0,001	0,033	0,915	0,086
O2D2 vs O2D3	0,006	0,031	0,465	0,359

Note: P-value was calculated based on statistics of F test which is a conversion of T2 Hotteling in MANOVA model

The result of multiple comparison shows that organic matter use with several dosages show a significant impact on Tulungrejo and Jurangkuali areas. This can be seen from the test result of multiple comparison where almost all treatment combinations shows significant differences.

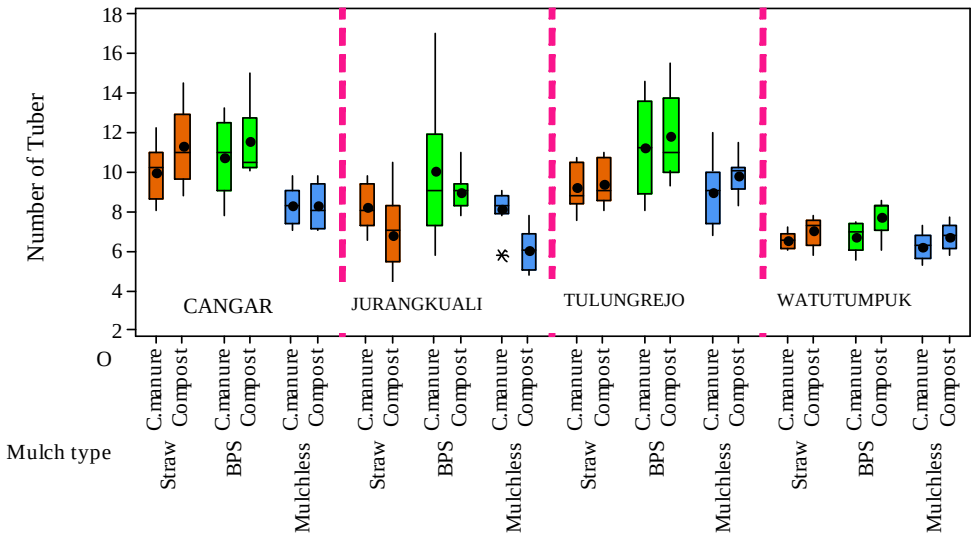


Figure 7. Number of Tuber in Various Mulches Uses in 4 Altitudes

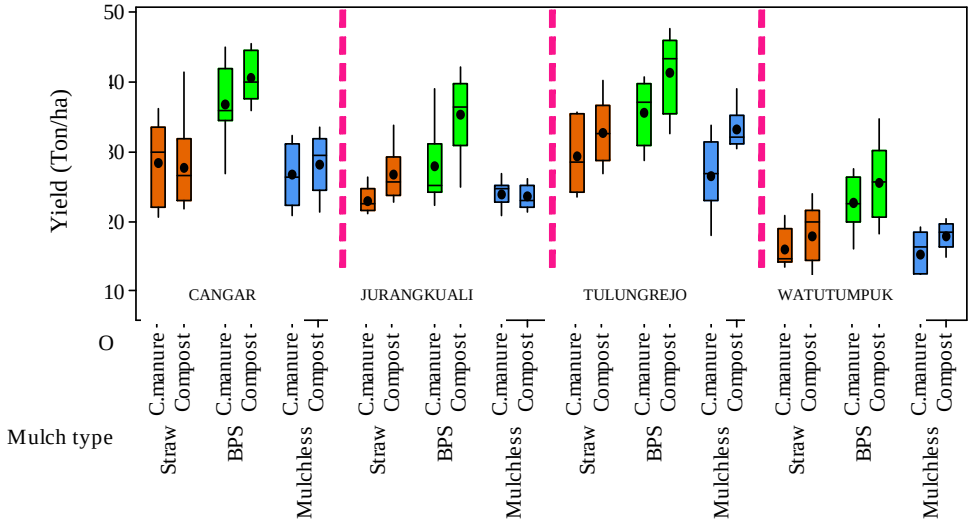


Figure 8. Potato Yield (ton/ha) in Various Mulch Uses in 4 Altitudes

4. Conclusion

Growth and production of potatoes in 4 different sites show the same pattern. The highest growth and production was obtained in Tulungrejo. Black Plastic Silver mulch and compost give the highest growth and production in 4 locations.

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