

# Study in the Use of Organic Mulch and Varieties on Production Cabbage (*Brassica oleraceae* L.) at Different Altitude

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## Abstract

This study aims to assess the effect of various types and varieties of organic mulch on the quantity and quality of cabbage plants (*Brassica oleraceae* L.) at various altitudes. This research using Random Design Group (RDG) arranged as factorial by 2 factors. The first factor is testing four varieties of cabbage: V1 (KK-Cross), V2 (Grand 11), V3 (Silvia), V4 (Talents). The second factor is testing a variety of organic mulch: M0 (without mulch), M1 (rice straw mulch), M2 (rice husk mulch). The results showed that the KK Cross varieties have crop weight (1226.11 g) or 49 tons  $\text{ha}^{-1}$  heavier than other varieties at an altitude of 110 meters above sea level. At an altitude of 400 meters above sea level Grand 11 Varieties resulted in crop weight (1125.00 g) or 45 ton  $\text{ha}^{-1}$  is heavier than other varieties. Furthermore, at an altitude of 1350 meters above sea level Grand 11 varieties produce crop weight (1055.56 g) or 42.2 tons  $\text{ha}^{-1}$  heavier than other varieties. 3). Rice straw mulch is better at producing crop volume (985.25 ml) than other organic mulch treatment at an altitude of 110 meters above sea level. At an altitude of 400 above sea level rice husk mulch is better (831.83 ml) in producing the crop volume and at an altitude of 1350 meters above sea level treatment without mulch is better (984.83 ml) in volume produces of crop compared to other treatments 4). Indicators of crispy on cabbage planted at an altitude of 110 meters above sea level is the Talent without mulch and mulch varieties of rice husks and varieties Grand 11 mulched straw and rice husks. At an altitude of 400 meters above sea level the crispy indicators are on the variety KK Cross with straw rice mulch. At an altitude of 1350 meters above sea level crispy indicators contained in all varieties that were given rice straw mulch and KK Cross varieties with rice husk mulch.

**Keywords:** Mulch, Quality, Quantity and Cabbage.

## 1. INTRODUCTION

Various studies of food consumption in general revealed that the consumption of vegetables and fruit per capita income has greater income elasticity than the food consumption of carbohydrates and the elasticity values are greater in households with higher income levels. That is, the economic development which has led to an increase in household income will lead to an increase in consumption per capita which is higher in vegetable varieties and fruit compared to carbohydrate foods.

The Increased per capita consumption is expected to be faster in urban areas than rural areas because the income elasticity of fruit and vegetable consumption tends to be higher in urban areas. This trend may occur because the income of the urban population is greater than the villagers and changing consumption patterns associated with social dynamics such an understanding of the nutrients in general are better in the city area.

That fact becomes initial data to be used as a benchmark in the development of cabbage commodity. This is corroborated by the results of the analysis of the World Bank in 1991, the demand for vegetables in Indonesia is projected to increase by 5 percent per year between 1998 and 2010. Cabbage plays an important role in the food industry of the country, because it can be processed into a variety of dishes from street food stalls to five star hotels.

The data of cabbage production in Central Sulawesi region in 2010 was 3.752 ton, in 2011 was 4,001 tons, in 2012 was 1,139 tons and in 2013 was decreased to 871 tons. Entering the year of 2014, the production rose to 8.510 tons (Central Bureau of Statistics and the Directorate General of Horticulture, 2014). The figure shows that the potential of this type of cabbage vegetable is still relatively high, it can be seen from the marketing distribution of cabbage from Palu can be marketed inter-islands such as to Kalimantan.

The figure shows that the potential of this type of cabbage is still relatively high, it can be seen from the high demand of this kind of vegetables from the sea food restaurants that spread in urban areas to the countryside. Besides, these kinds of vegetables are chosen by the inter-island traders as business commodities that possess high demand.

## 2. MATERIALS AND METHODS

### 2.1 Time and Setting of Research

This research was conducted at three different locations: The altitude of 110 m above sea level ( $0^{\circ} 55'50''$  South latitude and  $119^{\circ} 19'21''$  east longitude, 110 meters above sea level), Altitude 400 m ( $1^{\circ} 58'53''$  South latitude and  $120^{\circ} 21'26''$  Longitude east, 400 meters above sea level) and at altitude of 1350 m above sea level ( $1^{\circ} 6'44''$  South Latitude and  $120^{\circ} 55'07''$  east longitude, 1350 m above sea level). The research was conducted from April to August 2014.

## 2.2 Design of Experiments and Technical Implementation

Research using Random Group of Factorial pattern with 2 treatment factors, the first treatment is testing four varieties of cabbage: V1 (KK-Cross), V2 (Grand 11), V3 (Silvia), V4 (Talents). The second factor is the straw mulch treatment with levels: M0 (without mulch), M1 (rice straw mulch), M2 (rice husk mulch). The overall combination is 12 treatments with the total number of plots is 36 sample plots at each research site.

Data obtained during the observations were subsequently analyzed by analysis of variance and if there is a difference between the treatments then continued by Honestly Significant Difference Test (HSD) 5%.

## 3. RESULTS AND DISCUSSION

### 3.1 Number of leaves

Table 1 show that the interaction between rice straw mulch and KK Cross varieties at altitude of 110 m above sea level produced the highest number of leaves (4.78). At an altitude of 400m above sea level the grand 11 varieties which was given rice husk mulch have the highest number of leaves (5.44) compared to other treatments. While at an altitude of 1350m above sea level, the variety of Talenta without mulch produced the highest number of leaves (4.67) compared to other treatments. The condition indicated that cabbage grown in lowland require micro climate conditions around the plants not to be overheat. Because it is known that at that age, the plants are still in the vegetative phase characterized by the formation of vegetative organs.

Solo Samosir and Ambo Ala (2002) suggests the young plants that grow well can develop roots more quickly to absorb nutrients available in the soil before the soil washed away or fixed. Sufficient supply of nutrients from the roots to the top of the plant can support the growth of the plant canopy. Plant canopy that grow faster can cover the ground earlier and directly influent in reducing water evaporation from the soil.

Gunasekera G.P. research results, (2006) explains that the early growth of cabbage is supported by a lower temperature because it will accelerate the rate of formation of the canopy, the interception of radiation and increase transpiration produces high dry material. Soil moisture surface layer is better preserved can increase nutrient uptake by plant roots. The above mentioned conditions supported with rice straw mulching brindle arranged between the crop rows double rows system. Rice straw mulch in this way is relatively thicker and denser so that its influence in conserving ground water and suppress weeds is greater.

Table 1. The Number of Leaves of 20 DAP Cabbage with Mulch Treatment and Varieties in Various altitude.

Altitude	Mulch	Varieties				HSD 5 %
		KK Cross	Grand 11	Silvia	Talenta	
110m above sea level	Without Mulch	3,56 a	3,78 a	3,78 a	3,44 a	<b>0,96</b>
	Rice straw mulch	4,78 b	3,67 a	3,56 a	4,00 ab	
	Rice husk mulch	4,11 ab	3,89 ab	3,44 a	3,56 a	
400m above sea level	Without Mulch	3,22 a	3,67 a	3,56 a	3,89 a	<b>0,98</b>
	Rice straw mulch	3,67 a	4,11 a	4,11 a	3,78 a	
	Rice husk mulch	3,48 a	5,44 b	4,11 a	3,89 a	
1350m above sea level	Without Mulch	3,67 a	5,00 c	3,44 a	4,67 bc	<b>0,77</b>
	Rice straw mulch	3,33 a	3,67 a	3,44 a	3,44 a	
	Rice husk mulch	3,56 a	4,00 a	3,44 a	4,11 b	

Note : The number that accompanied by letter is similar to the similar rows are not significantly different at HSD 5% Test.

### 3.2 Leaf Area Index

Leaf area index is a picture of the leaf surface area ratio of land occupied by crops growing. The growth rates of the plants are affected by the rate of net assimilation and leaf area index. The net assimilation rate is high and optimum leaf area index can improve plant growth. Increased leaf area in the absorption of CO<sub>2</sub> for photosynthesis is supported by the structure of the leaves are ideal even in conditions of environmental stress is the ability of plants to adapt in order to remain sustainable (Gardner, *et al.*, 1991). According to June (2003), Leaf is one of the most important organs of the plant. Leaves are the place for the photosynthesis process to draw up the plant dry materials.

Table 2 shows that the widest leaf area index for KK Cross varieties which were given rice straw mulch at an altitude of 110 m above sea level has relation to the number of leaves. This is consistent with Gomie's *et al.* (2012) result research that the leaf area index is closely related to the number of leaves. Leaf is the main organ that functions in photosynthesis because the leaves have pigments that play a role in absorbing the sunlight. The energy of the Sunlight needed for the process plant growth and development of plants. The sunlight received by the leaves in large quantities will provide more leaves formation compared to the leaves that received fewer sunlight.

Table 2. The 40 DAP Cabbage leaf area index As a result of mulch and Variety in Different Altitudes

Altitudes	Mulch	Varieties				HSD 5 %
		KK Cross	Grand 11	Silvia	Talenta	
110 m above sea level	Without Mulch	0,46 a	0,44 a	0,42 a	0,41 a	<b>0,05</b>
	Rice straw mulch	0,52 b	0,42 a	0,41 a	0,43 a	
	Rice husk mulch	0,45 a	0,44 a	0,43 a	0,43 a	
400 m Above sea level	Without Mulch	0,40 a	0,43 a	0,41 a	0,40 a	<b>0,07</b>
	Rice straw mulch	0,40 a	0,45 a	0,40 a	0,41 a	
	Rice husk mulch	0,40 a	0,55 b	0,41 a	0,41 a	
1350 m Above sea level	Without Mulch	0,42 a	0,59 b	0,40 a	0,45 b	<b>0,08</b>
	Rice straw mulch	0,36 a	0,42 a	0,38 a	0,40 a	
	Rice husk mulch	0,40 a	0,43 a	0,41 a	0,41 a	

Note : The number that accompanied by letter is similar to the similar rows are not significantly different at HSD 5% Test.

### 3.3 NAR and CGR

The highest Value of net assimilation rate (Table 3) is on an altitude of 110m above sea level on a variety of Talenta by using rice straw mulch and the lowest is at an altitude of 400m above sea level on a variety of Talenta by using rice husk mulch. It is suspected that the rice straw mulch at altitude of 110m above sea level have not been able to suppress a high temperature around the plant, causing the respiration rate is high compared to the Talenta variety of other treatments. By contrast, in an altitude of 400m above sea level Talenta which were given rice husk mulch would have a low net assimilation value rate, it means that the response varieties of Talenta by using rice husk mulch is low in utilizing the temperature around the plant.

The growth rate of the plant is the plant's ability to produce dry ingredients result of assimilation per unit area per unit time ( $\text{g cm}^{-2} \text{day}^{-1}$ ). The growth rate of the plants running at maximum speed when the temperature is at the optimum conditions (suitable), if other factors are not to be limiting (Jumin, 2002).

The result of the research (Table 4) showed that the varieties of KK Cross which were given rice straw mulch and planted at an altitude of 110m above sea level, contributes a higher value on the growth rate of plants compared to other treatments. This indicates that rice husk mulch around the plant was able to maintain a good temperature for plant growth of KK Cross cabbage varieties grown at an altitude of 110m above sea level. The results of research of Nkansah *et al* (2003) explains that mulching with organic materials rice husk able to maintain soil temperature and humidity around the plant compared to controls in tomato plants. Soil temperature and humidity suitable for KK Cross cabbage as shown by some researchers that the KK-Cross planted in climates between 18.6 - 26,9<sup>0</sup>C can have weight up to 2,52 kg crop<sup>-1</sup> (Nathoo, *et al.*, 1998). The results of this research is also supported by the high net assimilation rate in KK Cross with rice straw mulch and rice husks mulch are no different from the varieties of Talenta at an altitude of 110 m above sea level.

Table 3. Net Assimilation Rate (NAR) 50 DAP ( $\text{g cm}^{-2} \text{day}^{-1}$ ) Cabbage as result of mulch Application and Variety in Different Altitude

Altitude	Mulch	Varieties				HSD 5 %
		KK Cross	Grand 11	Silvia	Talenta	
110 m Above sea level	Without Mulch	0,0040 a	0,0042 a	0,0044 a	0,0050 a	<b>0,0015</b>
	Rice straw mulch	0,0041 a	0,0042 a	0,0042 a	0,0066 b	
	Rice husk mulch	0,0043 a	0,0042 a	0,0042 a	0,0041 a	
400 m Above sea level	Without Mulch	0,0040 ab	0,0037 ab	0,0037 ab	0,0038 ab	<b>0,00096</b>
	Rice straw mulch	0,0036 ab	0,0038 ab	0,0038 ab	0,0038 ab	
	Rice husk mulch	0,0044 b	0,0037 ab	0,0036 ab	0,0031 a	
1350 m Above sea level	Without Mulch	0,0040 a	0,0040 a	0,0038 a	0,0039 a	<b>0,0082</b>
	Rice straw mulch	0,0040 a	0,0039 a	0,0050 b	0,0041 a	
	Rice husk mulch	0,0040 a	0,0040 a	0,0041 a	0,0041 a	

Note : The Number that Accompanied by letter is similar not significantly different at HSD 5% Test.

Tabel 4. Crop Growth Rate (CGR) 40 DAP ( $\text{g cm}^{-2} \text{ day}^{-1}$ ) Cabbage as result of Mulch Application and Varieties in different altitudes.

Altitude	Mulch	Varieties				HSD 5 %
		KK Cross	Grand 11	Silvia	Talenta	
110 m Above sea level	Without Mulch	$3,7 \times 10^{-5}$ b	$3,4 \times 10^{-5}$ ab	$3,1 \times 10^{-5}$ ab	$2,5 \times 10^{-5}$ a	<b><math>1,0 \times 10^{-5}</math></b>
	Rice straw mulch	$5,3 \times 10^{-5}$ c	$3,3 \times 10^{-5}$ ab	$3,4 \times 10^{-5}$ ab	$3,2 \times 10^{-5}$ ab	
	Rice husk mulch	$4,0 \times 10^{-5}$ bc	$3,5 \times 10^{-5}$ ab	$3,3 \times 10^{-5}$ ab	$2,9 \times 10^{-5}$ ab	
400 m Above sea level	Without Mulch	$2,3 \times 10^{-5}$ a	$2,5 \times 10^{-5}$ a	$2,6 \times 10^{-5}$ a	$2,5 \times 10^{-5}$ a	<b><math>8,0 \times 10^{-5}</math></b>
	Rice straw mulch	$2,4 \times 10^{-5}$ a	$3,1 \times 10^{-5}$ ab	$2,8 \times 10^{-5}$ ab	$2,7 \times 10^{-5}$ a	
	Rice husk mulch	$2,4 \times 10^{-5}$ a	$3,6 \times 10^{-5}$ b	$2,8 \times 10^{-5}$ ab	$2,8 \times 10^{-5}$ ab	
1350 m Above sea level	Without Mulch	$2,3 \times 10^{-5}$ a	$2,8 \times 10^{-5}$ ab	$2,5 \times 10^{-5}$ a	$3,3 \times 10^{-5}$ b	<b><math>6,0 \times 10^{-5}</math></b>
	Rice straw mulch	$2,5 \times 10^{-5}$ a	$2,6 \times 10^{-5}$ a	$2,6 \times 10^{-5}$ a	$2,7 \times 10^{-5}$ a	
	Rice husk mulch	$2,6 \times 10^{-5}$ a	$2,6 \times 10^{-5}$ a	$2,7 \times 10^{-5}$ a	$2,5 \times 10^{-5}$ a	

Note : The Number that Accompanied by letter is similar to the similar rows are not significantly different at HSD 5% Test.

### 3.4 The Age at Harvest

The types of rice straw mulch and rice husk influence the age at harvest (Table 5) KK Cross and Grand 11 varieties are faster in every research location. This shows that both varieties are able to respond to the range of temperatures that exist around the plant were given rice husk mulch, while the temperature range around the plants by applying the rice straw mulch and rice husk mulch was  $26.74^{\circ}\text{C}$  at an altitude of 110m above sea level,  $28.28^{\circ}\text{C}$  in an altitude of 400m above sea level and  $25.04^{\circ}\text{C}$  at an altitude of 1350 m above sea level. According to Dainello F.J *et al* (2009), the use of rice husk mulch and rice straw mulch on the cultivation of cabbage in hot climates will support faster crop harvest time than the use of solid and plastic mulch. But even better is rice husk mulch, it is due to the nature of rice husk mulch more nests than rice straw mulch. The soil moisture under the mulch nest is lower than the soil moisture under dense mulch.

Table 5. The Age At Harvest of Cabbage (days) As a result of Mulch treatment and Variety in Different Altitude.

Altitudes	Mulch	Varietas				HSD 5 %
		KK Cross	Grand 11	Silvia	Talenta	
110 m Above sea level	Without Mulch	70,00 bcd	72,00 cd	73,00 cd	74,00 d	<b>5,53</b>
	Rice straw mulch	57,00 a	66,67 b	68,33 bc	67,67 bc	
	Rice husk mulch	66,00 b	67,67 bc	70,00 bcd	72,00 cd	
400 m Above sea level	Without Mulch	73,67 b	68,00 ab	70,33 b	70,00 b	<b>7,86</b>
	Rice straw mulch	73,67 b	69,67 ab	68,33 ab	70,33 b	
	Rice husk mulch	73,33 b	56,00 a	66,67 ab	69,67 ab	
1350 m Above sea level	Without Mulch	70,67 bc	64,33 b	68,00 bc	67,67 bc	<b>7,64</b>
	Rice straw mulch	72,67 c	66,33 bc	69,33 bc	68,33 bc	
	Rice husk mulch	70,33 bc	55,33 a	71,67 bc	68,00 bc	

Note : The Number that Accompanied by letter is similar to the similar rows are not significantly different at HSD 5% Test.

### 3.5 The Wet Weight of Crop

Effect of rice straw mulch treatments able to produce the highest crop wet weight and significantly different from those without mulch varieties KK Cross altitude 110 meters above sea level (lowlands) of  $1226.67 \text{ g}$  equivalent to  $49 \text{ ton ha}^{-1}$  exceeds the production the description, but not different rice husk mulch. It is suspected of rice straw mulch able to maintain micro-climatic conditions (soil temperature) so that helps plants absorb nutrients properly. The condition has also been proved by Edyta Koesterna (2014) who found their real effect of rice straw mulch  $20 \text{ ton ha}^{-1}$  compared with no straw mulch on the observation of wet weight of broccoli planted at different times.

Furthermore, rice husk mulch provides the highest wet weight crop varieties altitude of 400 meters above sea Grand 11 (middle plains) of  $1125.00 \text{ g}$  equivalent to  $45 \text{ ton ha}^{-1}$  and was significantly different from other treatments. These results suggested that the ability of mulch to retain soil temperature and moisture better than rice straw mulch at medium altitude. It can be seen in the field that rice husk mulch cover more equal than rice straw mulch on the experimental plot. Biological research results Erita *et al.*, (2010) found that rice husk mulch real influence on all components of the production of maize crops were planted at an altitude of 500 m above sea level.

Treatment without mulch altitude of 1350 meters above sea level it produces a wet weight of the highest crop varieties Grand 11 amounted to  $1055.67 \text{ g}$  equivalent to  $42 \text{ ton ha}^{-1}$  but not significantly different from other

mulch treatments. This indicates that at high altitude the temperature range in treatment without mulch seen in figure 1 is able to donate the proceeds to the Grand 11 varieties better than the temperature in other mulch treatment. Weight loss wet crop in cold regions, especially at higher elevations have also been raised by Rodriguez (2015) which states that the cabbage plant that grows in the cold temperature will cause a decrease in the wet weight of the crop by 50%.

Table 6. The Average Crop Wet Weight (g) As a result of Mulch Treatment and Variety in Different Altitude.

Altitude	Mulch	Varieties				HSD 5 %
		KK Cross	Grand 11	Silvia	Talenta	
110 m	Without Mulch	1117,00 b	783,33 a	897,00 a	833,33 a	
Above sea level	Rice straw mulch	1226,67 b	1191,33 b	900,00 a	805,00 a	<b>282,79</b>
	Rice husk mulch	1176,33 b	918,00 a	881,33 a	813,33 a	
400 m	Without Mulch	883,33 ab	958,33 abc	866,67 ab	816,67 a	
Above sea level	Rice straw mulch	800,00 a	956,67 abc	1031,67 cd	893,00 ab	<b>170,65</b>
	Rice husk mulch	877,78 ab	1125,00 d	968,33 abc	995,00 bc	
1350 m	Without Mulch	833,69 ab	1055,67 c	950,00 bc	1050,00 c	
Above sea level	Rice straw mulch	666,67 a	993,33 bc	676,67 a	983,33 bc	<b>232,50</b>
	Rice husk mulch	750,00 ab	1033,33 c	893,35 ab	789,00 ab	

Note : The Number that Accompanied by letter is similar to the similar colour are not significantly different at HSD 5% Test.

### 3.6 The Crop Volume

The highest crop volume (985.25ml) is contained in rice straw mulch treatment at an altitude of 110m above sea level, at an altitude of 400m above sea level the highest crop volume (831ml) is contained in the rice husk mulch treatment and at an altitude of 1350m above sea level the highest crop volume (984, 83 ml) is on treatment without mulch. The treatment of KK Cross and Grand 11 varieties resulting in highest crop volume in altitude 110m above sea level, Bobo and Wino Wanga and significantly different from other treatments. It is suspected that both varieties suitable for the formation of the volume of the crop in the highlands (Bobo and Wino Wanga), whereas KK Cross variety is appropriate in low-lying areas (Jono Oge) as shown in the release of hybrid varieties in the Decree of the Minister of Agriculture Number: 337 / Kpts / SR.120 / 5/2006 and No. 390 / Kpts / SR.120 / 10/2005).

Table 7. Volume of Cabbage (ml) As a result of Mulch Treatment and Variety in Different Altitude

Treatment	Crop Volume		
	110m above sea level	400m above sea level	1350m above sea level
Without Mulch	833,17 a	694,58 a	984,83 b
Rice straw mulch	985,25 b	766,58 ab	873,75 a
Rice husk mulch	911,17 ab	831,83 b	941,67 ab
HSD 5%	90,18	100,35	68,95
KK Cross	1092,11 c	514,44 a	775,00 a
Grand 11	938,44 b	1053,44 d	1111,11 d
Silvia	879,22 b	820,00 c	897,22 b
Talenta	730,00 a	669,44 b	950,33 c
HSD 5%	125,73	139,91	96,14

Note : The Number that Accompanied by letter is similar to the similar colour are not significantly different at HSD 5% Test.

### 3.7 The Total of Plant Dry Weight

The high total dry weight of cabbage plants (Table 8) planted at an altitude of 400m above sea level using a mulch of rice husk indicates that the use of mulch can keep the moisture in the soil where plants grow in the lowlands so as to generate a total weight of cabbage plants are high, the main varieties in accordance with the terms grew desired. According to Noorhadi and Sudadi (2003) quoted by Nurheni Vitello and Nurunnajah (2010) the air and soil moisture, the temperature of air and soil plants, and each relating to realize the optimal environmental conditions for plants. As stated by (Wade *et al.* 1983 and Harith, 2000) that the mulch of rice straw on the soil surface in addition to functioning as an organic material, it can also improve the physical, chemical and biological soil in order to obtain the resistance of nutrients and water, improve soil structure, lowering the temperature of the soil, reducing excessive evaporation, reduce weeds and reduce erosion while straw mulch with its nature that easily weathered thus improving soil fertility.

Table 8. The Total of Plant Dry Weight (g) As a result of Mulch Treatment Mulch and Variety in Different Altitude.

Treatment	The Total of Plant Dry Weight		
	110m above sea level	400m above sea level	1350m above sea level
Without Mulch	272,30	199,88 a	252,88 b
Rice straw mulch	350,99	217,41 a	209,70 a
Rice husk mulch	284,79	285,42 b	192,17 a
HSD 5%		52,02	42,49
KK Cross	420,00 c	130,60 a	147,86 a
Grand 11	329,01 b	373,25 c	313,11 c
Silvia	260,07 ab	264,97 b	180,84 a
Talenta	201,69 a	168,11 a	231,18 b
HSD 5%	94,33	72,53	59,25

Note : The Number that Accompanied by letter is similar to the similar colour are not significantly different at HSD 5% Test.

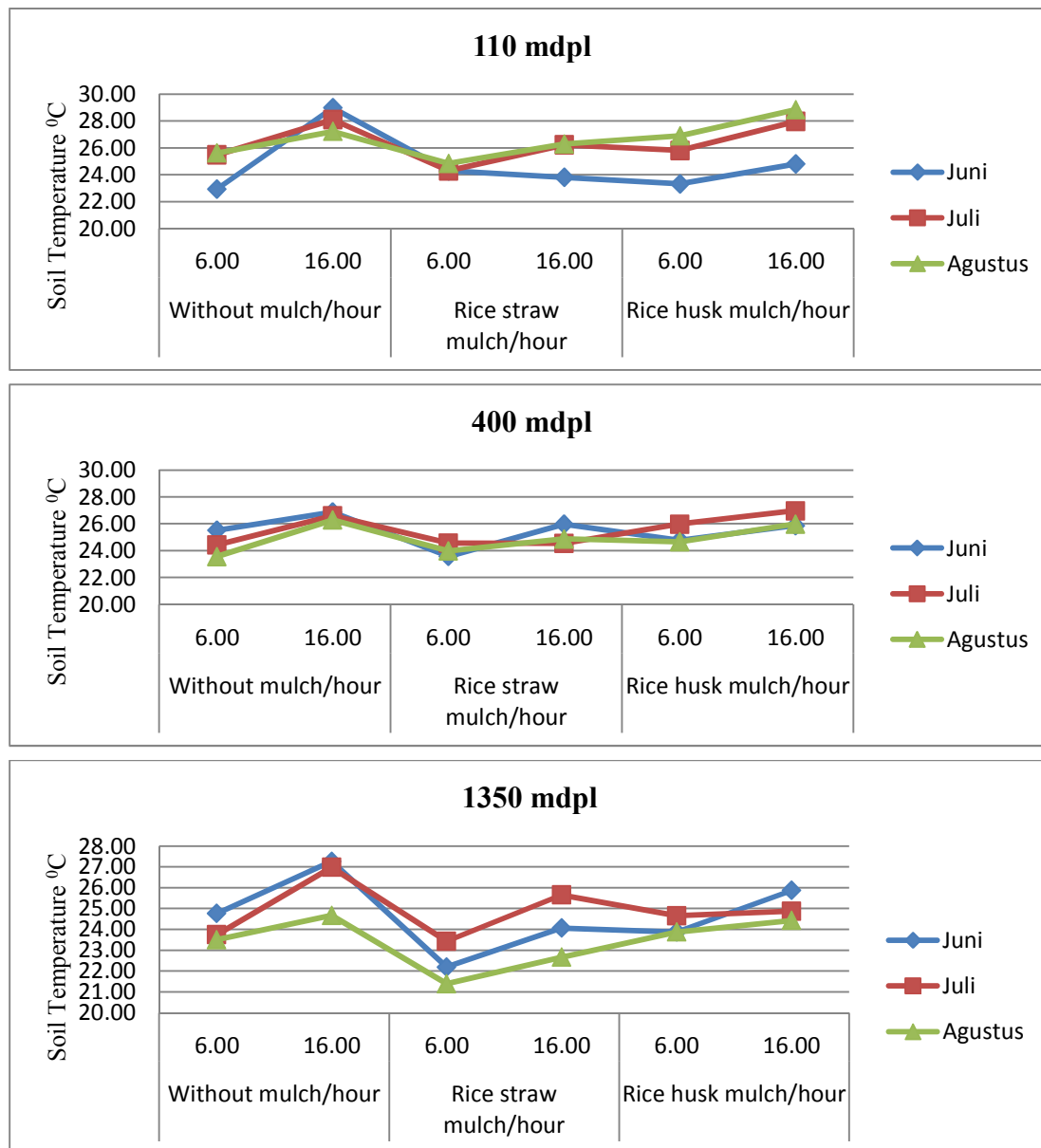


Figure 1. The soil temperature fluctuations at various altitude research

#### 4. CONCLUSION

The KK Cross variety has weighs crop of 1226.11g (49 ton ha<sup>-1</sup>) heavier than the other varieties at an altitude of 110m above sea level. At an altitude of 400m above sea level the Grand 11 variety produce weight crop of 1125.00g (45 ton ha<sup>-1</sup>) heavier than the other varieties. Furthermore, at an altitude of 1350m above sea level Grand 11 variety produces weight crop of 1055.56g (42.2 ton ha<sup>-1</sup>) heavier than the other varieties. Rice straw mulch on Grand 11 variety is better (1081.44ml) in producing the volume of crop compared to other treatments.

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