Effect Of Shade, Organic Materials And Varieties On Growth And Production Of Upland Rice

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Abstract: There is a shade factor and low organic matter content of the soil is a problem that needs to be addressed in the development of upland rice cultivation as intercrops in the plantation area. Based on these considerations, then one study that needs to be done is to conduct experiments on the effect of shade factor combined with the the provision of the organic material to the some varieties of upland rice that has been recommended nationally. The objective of experiment is to study the influence of shade, organic materials and varieties on the growth and production of upland rice. This research using experimental design of Split - Split Plot Design with 3 treatment factors and 3 replications or blocks. The first factor is the treatment of shade with 3 levels shade percentage (0%, 20% and 40%). The second factor is the dosage of organic material consists of 3 levels (0 g / polybag, 25 g / polybag, 50 g / polybag and 75 g / polybag). The third factor is the treatment of varieties consists of 4 types of upland rice varieties (Si Kembiri, Situ Patengggang, Situ Bagendit and Tuwoti). The research results showed that the effect of shade on upland rice varieties decrease number of tillers, number of panicles, number of productive grains, grain production per hill of uplnd rice plants and total sugar content of upland rice plants. Effect of organic matter increases number of panicles, number of productive grains, grain production per hill of upland rice plants and total sugar content of upland rice plants. It is known that the the variety of Situ Patenggang provides better growth and production compared with three other varieties (Si Kembiri, Situ Bagendit and Tuwoti) in shaded conditions.

Keywords: growth and production, organic materials, rice varieties, shade

1. INTRODUCTION

Factor of shade and low soil organic matter content is one of the issues that need to be addressed in the development of upland rice cultivation as intercrops in the area of the plantation. These factors can interfere with the development of plant morphological characteristics and metabolic processes resulting in the ability of the plant to be relatively low productivity (Supijatno, 2003). Factor of shade, but will affect plant morphology changes will also affect the quality of upland rice grain obtained (Steinway *et al*, 2003; Marschner, 1995; Sitompul and Guritno, 1995). Shade may also influence changes in the anatomy of the leaf tissue of plants that change in the epidermis and mesophyll tissues. The changes are the mechanism for controlling the amount of light intensity that can be used by the chloroplast of leaves. The leaves of upland rice varieties, that is tolerant and sensitive to shade, there are different responses when seen from the greenish color of the leaves, which is characterized among other things by the amount of leaf chlorophyll and leaf area (Chozin *et al*., 2000; Sahardi, 2000; Sopandie et al., 1999). These factors contribute to determine the efficiency of photosynthesis in the leaves of plants. Tolerance mechanism of plants to sustain growth and development remain well in shaded conditions can be done by increasing leaf area, increase photosynthetic capacity per unit of light energy received as well as increasing the total sugar content of plants (Fitter and Hay, 1981; Gardener *et al*, 1985).

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Hale and Orcutt (1987) also said that the mechanism of plant tolerance to shade can be done by increasing the leaf area in an effort to reduce the use of metabolites and reduce the amount of light transmitted and reflected by the leaves. According to Lubis *et al*. (1993) that for the development of the cultivation of upland rice as a crop sidelines under the shade of tree stands required early duration rice varieties to moderate (80-120 days), plant height ranges from 110-125 cm, the potential number of tillers is moderate, form hill of stems rather hoarse, blast resistant, tolerant of Al, drought and shade. Organic material effect on the physical properties, chemical and biological properties of soil as well as on the quality of growth and crop production (Hardjowigeno, 1986; Sutanto, 2002). The role of organic matter can be as granulator soil to improve soil structure, sources of plant macro and micro nutrients, although in a low, increase the ability of soil to hold water and increase the cation exchange capacity of plant nutrients as well as the main energy source for the activity of soil microorganisms so as increasing soil biological activities. As a result, plants become better growth when given organic material. On the sour soil, organic matter can improve soil pH by neutralizing the effect of Al by forming Al-organic complexes and can increase the availability of micronutrients through a chelate complex micro elements with organic materials. Based on the above considerations, the one study that needs to be done is to study the influence of shade combined with a dose of organic matter to some upland rice varieties that have been recommended nationally. For this experiment, then studied three types of national varieties of upland rice and one type of adaptive local varieties of North Sumatera with the treatment of three different levels of shade and four dose levels of organic matter. The combination effect of shade treatment and organic matter to the growth and production of upland rice plants is estimated to vary depending on upland rice varieties were planted. The plants parameters which were observed in this study consisted of number of tillers, number of panicles, number of productive grain, grain production per hill of plants and total sugar content of the plants. The objective of the experiment was

to study the influence of shade, organic matter, and varieties on the growth and production of upland rice plants.

2. MATERIALS AND METHODS

2.1. Location of research

The experiment was conducted at the screen house in experimental garden, Faculty of Agriculture, University of Sumatera Utara, Medan, Indonesia, located at an altitude of 25 meters above sea level. The experiment took place from February to November 2008.

2.2. Materials and research tools

Materials used in the study consisted of upland rice seeds of 4 varieties (Si Kembiri, Situ Patenggang, Situ Bagendit and Towuti), top soil, compost organic fertilizer of empty bunches of oil palm, Urea, TSP and KCl, black polythene bags and insecticides. The equipment used consisted of sieve mesh size of Ø 6 mm, 25 kg capacity portable scales, digital scales capacity of 0.5 kg, wood, nails, boards lat, triplex, digital lux meter, plastic tubing, plastic bucket, net polyethilen, raffia, solo sprayer and hand sprayer, digital camera, soil thermometer, soil tester and hygrometer.

2.3. Research design

In this study, experimental units are arranged according to the experimental design Split-Split Plot Design with three treatment factors, namely :

a. The first factor, shade treatment (N) as the main plot consists of three levels shade :

1. N1 = 0%
2. N2 = 20%
3. N3 = 40%

b. The second factor, the treatment of organic matter as a subplot consisted of four dose levels :

1. B0 = 0 g/polybag
2. B1 = 25 g/polybag
3. B2 = 50 g/polybag
4. B3 = 75 g/polybag

c. The third factor, treatments varieties as sub-subplots comprised four varieties :

1. V1 = Si Kembiri (local Sumatra Utara)
2. V2 = Situ Patenggang
3. V3 = Situ Bagendit
4. V4 = Towuti

The sum of all treatments consisted of 48 treatments combinations with 3 replications or blocks. The total number of experimental plant was 432 plants with a sample of 144 plants.

2.4. Implementation of research

Building of shade treatment provided 6 units, made of wood and boards lat. The dimensions of each unit of building shade: length = 4.5 m, height = 2.0 m, width = 2.4 m. To get the shade treatment levels : 0%, 20%, and 40% of the distance between lat boards as a roof of the building arranged according to the following formula :

$$I = \frac{n}{n + r}$$

(Delvian, 2005)

where:

I = Intensity of the desired shade (%)
n = Distance between lat board (cm)
r = Width of lat board (cm)

The building of shade is placed in the house screen as a place of experiment. Soil as a growing medium used top soil. Soil wind dried for 15 days, then destroyed and sieved with a diameter of 6 mm sieve. Soil that has been sieved, stirred evenly and then put into polybags, weighing 10 kg on each polybag. The total number of polybags are 432 polybags. Soil in each polybag mixed with according dose of compost organic matter treatments (0 g / polybag = 108; 25 g / polybag = 108; 50 g / polybag = 108; 75 g / polybag = 108). Polybags filled with growing media that have been prepared under the auspices of the building at the screen house according treatment plan has been determined randomly. Distance between polybags in the same treatment = 25 cm, the distance between the different treatment = 50 cm and between replications = 1.5 m. Polybags placed on the bricks as a base in order to remain upright the position of polybags. Polybags which had been compiled and then quenched in water up to field capacity condition. At the time of planting, the water soil in the polybag conditioned in field capacity. In each of polybag, 5 seeds planted in a depth of 2.5 cm. After a one week old plants thinned up to 3 plants per polybag staying. Two days before planting, given a basic fertilizer N, P, K. Fertilizer N which first are given 1/3 dose, total = 5 g urea / polybag while fertilizer P, K are given at once respectively with the dose, P = 11 g TSP and K = 15 g KCl. Fertilizer stocked in a polybag and closed thin with the soil. After that polybag watered up to field capacity. Fertilization N 2nd and 3rd are given after the plant was 30 and 55 days after planting, respectively = 5 g urea / polybag, spread evenly around the plant at a distance of 5 cm from the plant and then lightly covered with the soil. During the maintenance of the plant if the two days straight there is no rain, then polybags watered up to soil water in polybags reaching field capacity condition. Watering is discontinued when the plant enters mature stage of the harvest. To control the plant of pest attack carried out by spraying insecticides of Decis and Marshall 25 EC every one to two weeks. Weeding is done by unplugging the weeds that grow in the polybag trial and that grow in the land of the experimental field by manuals equipment (crowbar / hoe) every two weeks. Harvesting is done after the rice grain yellowing around 90%.

2.4. Analysis of data

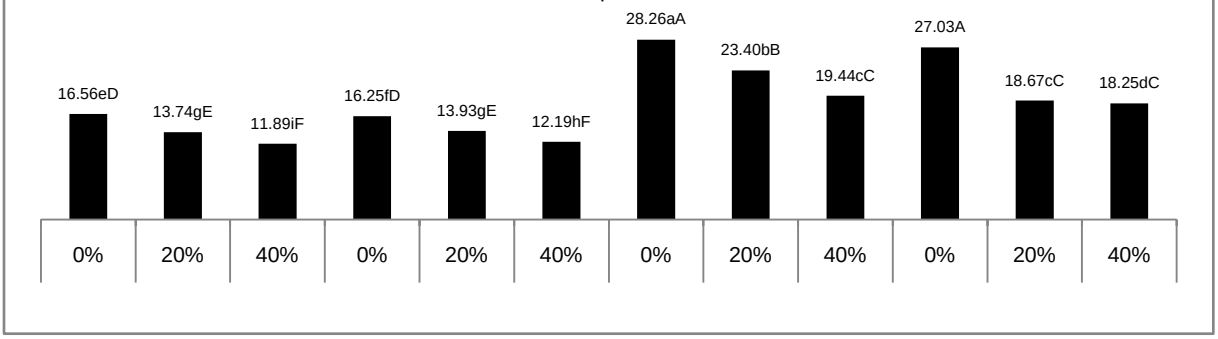
Data from the research were analyzed by using : analysis of variance (F-test), the mean difference test of Duncan's Multiple Range Test (MDRT) at the significance level of 1% and 5%, and by using histogram analysis.

3. RESULTS

3.1. Number of tillers

The number of tillers per hill of upland rice plants are very significantly affected by the interaction of varieties and the shade. The highest number of tillers found in variety of Situ Bagendit (V3) and Tuwoti (V4) in the shade of 0% and the lowest for the local variety of Si Kembiri (V1) in the shade of 40%. In all varieties tested is seen that the higher the percentage of the shade, the lower the number of tillers which can be produced by upland rice plants (See Figure 1).

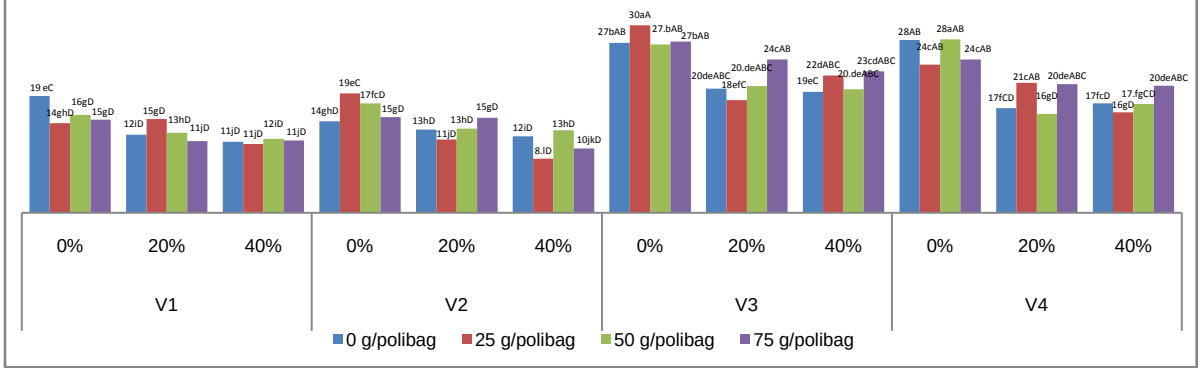
Figure 1
Effect Of Combination Treatment Of Varieties (V) And Shade (%) On Number Of Tillers Per Hill of Upland Rice Plants



3.2. Number of panicles

The number of panicles per hill of upland rice plants are very significantly affected by the interaction of varieties, shade, and organic matter. Variety with the highest number of panicles found in variety of Situ Bagendit (V3) in the 0% of the shade and organic material dose of 75 g / polybag plant. While the lowest was in the variety of Situ Patenggang (V2) in the the shade of 40% at a dose of organic matter 25 g / polybag plant (see Figure 2). There is a tendency that the number of tillers of each variety which assessed of decreasing with the higher intensity of the shade.

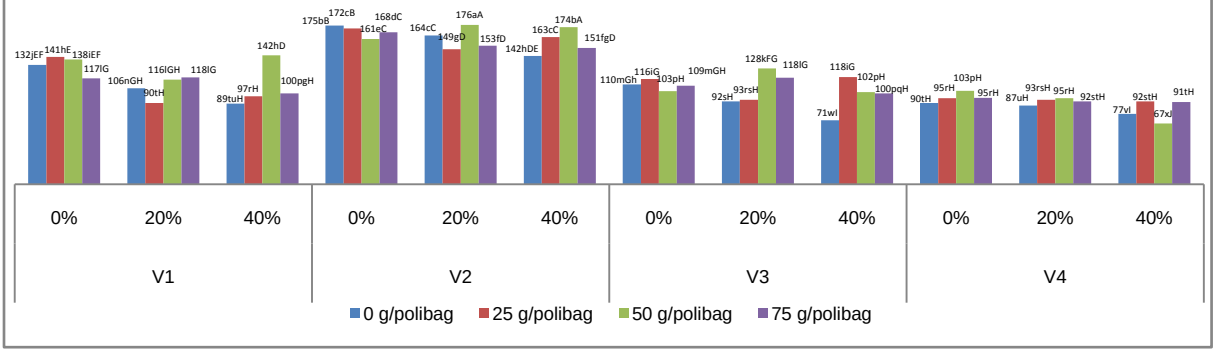
Figure 2
Effect Of Combination Treatment Of Shade (%), Dose Of Organic Materials (g/polybag) And Varieties (V) To Number Of Tillers Per Hill Of Upland Rice Plants



3.3. Number of productive grain per panicle

The number of prodcutive grains per panicle are very significantly affected by the interaction of varieties, shade and organic matter. The number of productive grains per panicle is highest in the variety of Situ Patenggang (V2) compared with other varieties (V1 = Si Kembiri, V3 = Situ Bagendit, V4 = Tuwoti) either in the the shade of 0 - 40% and in the dose of organic matter 0 - 75 g / polybag (see Figure 3).

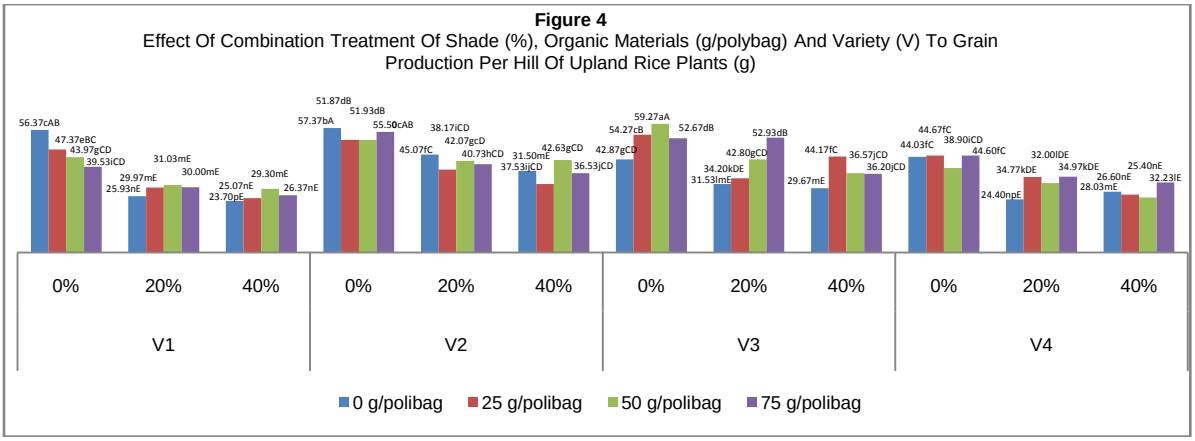
Figure 3
Effect Of Combination Treatment Of Shade (%), Dose Of Organic Materials (g/polybag) And Varieties (V) To Number Of Productive Grain Per Panicle Of Upland Rice Plants



3.4. Grain production per hill of plants (g)

Production of grain per hill of upland rice crop is very significantly influenced by the interaction of shade, dose of organic matter and varieties. Variety which has the highest production is generally found in Situ Patenggang variety (V2) as compared to other varieties both in shade of 0 - 40% and the organic material doses of 0 - 75 g / polybag (Figure 4). In each variety tested, there is a tendency the higher the percentage shade, grain production per plant clumps tend to decrease.

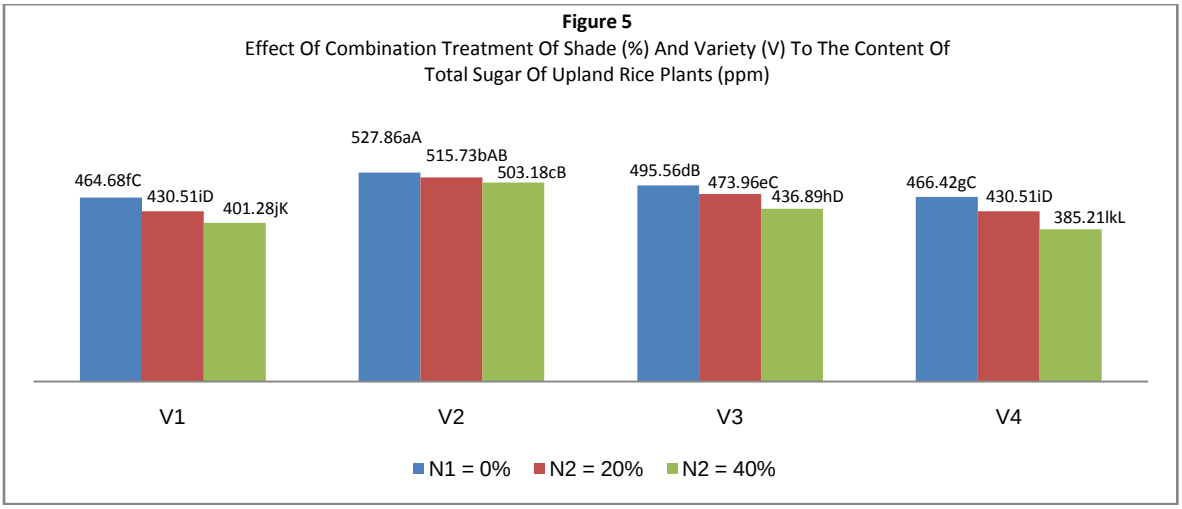
Figure 4
Effect Of Combination Treatment Of Shade (%), Organic Materials (g/polybag) And Variety (V) To Grain Production Per Hill Of Upland Rice Plants (g)



3.5. Total sugar content of plants

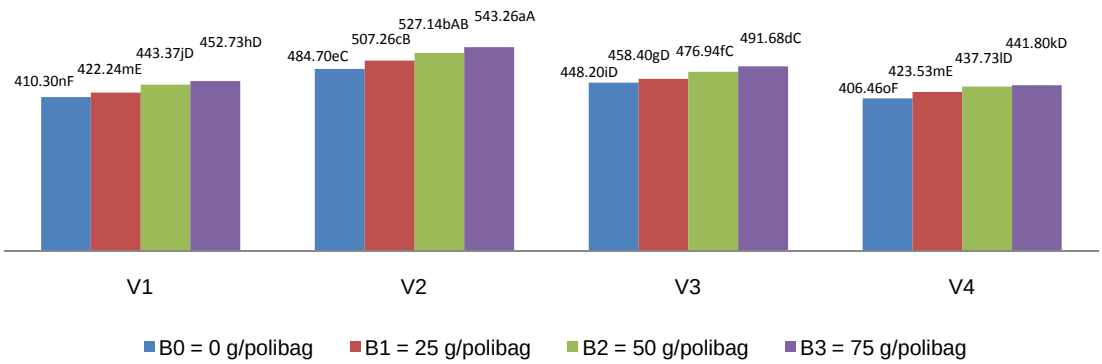
Total sugar content of plants (ppm) of upland rice is very significantly affected by the interaction of shade and variety and interaction of doses of organic materials and variety. The highest total sugar content found in variety of Situ Patenggang (V2) compared with other varieties (Si Kembiri, Bagendit, Tuwoti) in the shade of 0%, 20% and 40% (see Figure 5). The higher the percentage of shade looks a tendency decreases total sugar content of upland rice crop.

Figure 5
Effect Of Combination Treatment Of Shade (%) And Variety (V) To The Content Of Total Sugar Of Upland Rice Plants (ppm)



On the influence of interaction of organic materials and varieties it is seen also that the variety of Situ Patenggang (V2) has total sugar content of the plant which is the highest compared to the three other varieties in all doses of organic materials applied (0-75 g / polybag). It is likely that the higher dose of organic materials applied, the higher the total sugar content of plants in all upland rice varieties tested (Figure 6).

Figure 6
Effect Of Combination Organic Materials (B) And Varieties (V) To The Content Of Total Sugar Of Upland Rice Plants (ppm)



4. DISCUSSION

From the results of this research has been known that the interaction variety and shade effect is very significantly towards the parameters of number of tillers and total sugar content of plants. The highest number of tillers present in Situ Bagendit and Tuwoti variety and lowest for the local variety of Si Kembiri. In all varieties studied seen the higher the percentage of shade, the lower the number of tillers that can be generated by upland rice plants (Figure 1). The highest total sugar content of plants found in variety of Situ Patenggang compared with other varieties (Si Kembiri, Situ Bagendit, Tuwoti). Seen also that the higher the percentage of shade, there is a tendency of decreasing the total sugar content of upland rice plants (Figure 5). The tendency of emphasis of growth in the number of tillers and decreased levels of total sugars in the plant due to shade treatment of each variety is expected due to the decrease in the net proceeds of photosynthesis because a decrease in the intensity of light received by each variety in the presence of shade 20% and 40%. Weaver and Clement (1980) mentioned that the light from the sun is the energy source for the growth of plants to form carbohydrates through photosynthesis. In low light conditions result in disruption of metabolic processes in plants which implicates reduction in the rate of photosynthesis and carbohydrate synthesis for the plant growth (Murty *et al*., 1992; Watanabe *et al*., 1993; Jiao *et al*., 1993; Yeo *et al*., 1994; Chowdury *et al*., 1994 ; Sopandie *et al*., 2003). Response to a decrease in growth because shade treatment, there are differences in each variety. This is due to differences in genetic factors of each variety. Varieties that are physiologically more adaptive to the influence of shade based on the above parameters is shown by the variety of Situ Patenggang and Si Kembiri because a decrease in the number of tillers lower and for the the highest total sugar content of the plant is shown by the variety of Situ Patenggang. The high total sugar content of the variety of Situ Patenggang is in line with what was stated by Sopandie *et al* (1999 and 2001a) which stated that the tolerant variety of upland rice showed the starch content in the leaves and stems is higher than the sensitive varieties when the shaded by 50 % in active vegetative growth stage. The interaction of treatment variety and organic materials is very significantly effect on biochemical parameter of total sugar content of plants. The response of the total sugar content of plants in each of the tested variety tends to increase with increasing doses of organic materials given in plants (Figure 6). Response of the highest total sugar content was shown by the variety Situ Patenggang. It is known that the role of organic matter can improve the quality and quantity of plant growth and development including biochemistry of plants through its influence on the improvement of the physical, chemical and biological properties of soil as a medium for growing crops. This is in line with what was said by Rosmarkam and Yuwono (2002) which stated that the organic fertilizer can improve soil fertility because it can play a role to : improve soil structure, soil permeability, increasing the soil's ability to provide water for plants, increasing the cation exchange capacity, providing source of N, P, K, Ca, Mg, S and micronutrients and improve the the activities of soil biological life. The increase of cation exchange capacity physiologically will facilitate the provision and uptake of nutrients by plants for growth. Greenland and Dart (1972) in Sanchez (1992) also describes some of the advantages of organic matter in the soil for the cultivation which provides most of cation exchange capacities of the soil, helps formation of soil aggregate, thereby improving the physical properties of the soil and reduce the susceptibility to soil erosion, change anchoring properties of soil water, can form a amalgamation with nutrients that prevent the leaching of nutrients. All the circumstances mentioned above will have a positive influence on the growth and development of plants. On the interaction of three factors of the treatment research, namely varieties, shade and organic matter giving a very significantly influence on the parameters of number of panicles per hill of upland rice plants, number of productive grain per panicle, and grain production per hill of upland rice plants. It is seen that the response of number of panicles per hill of upland rice plants, number of grains productive per panicle, and the production of grain per hill of plants of each variety which is assessed on the shade at

various doses of organic material getting lower with increasing the percentage of shade (Figure 2, 3 and 4). It is known that upland rice plants classified the plant needs a lot of light, so the lack of light conditions result in disruption of metabolic processes which implicates reduction in the rate of photosynthesis and carbohydrate synthesis (Murty *et al*., 1992; Watanabe et al., 1993; Jiao et al., 1993; Yeo *et al*., 1994; Chowdhury *et al*., 1994; Sopandie *et al*., 2003). This factor directly in general affect the level of productivity of upland rice which is low in the shade. Steinway *et al*, (2003) stated low light intensity in shade conditions affecting the production and quality of upland rice the grain. Low light intensity lowering the yield of upland rice (Supriyono *et al*., 2000). Then Murty and Sahu (1987) explained that the low light intensity caused disruption of protein synthesis and low availability of carbohydrates, and high the grain emptiness. Low light intensity lower carbohydrate formed causing increased the grain empty (Chaturvedi *et al*., 1994). Effect of low light intensity caused number of grains per panicle be a little as well as the percentage of empty grains becomes high, thus resulting in low grains production (Sopandie *et al*., 2003). Of four varieties tested in this study there are differences in response to treatment effect of shade on different doses of organic material given on the parameters mentioned above. Varieties are more adaptive to shade conditions with various doses of organic matter shown by the variety of Situ Patenggang. Mohr and Schopfer (1995) stated that the ability of plants to adapt to the environment is determined by the genetic properties of plants. Genetically, shade tolerant of plants have high adaptability to environmental changes. On the influence of organic matter on four varieties tested at various levels of shade shown that the value of parameter of number of panicles per hill of plants, number of productive grains per panicle, and grain production per hill of plants are generally higher (better) compared with treatment without the provision of organic materials. Hardjowigeno (1986) and Sutanto (2002) stated that the organic material as fertilizer of plants provide a good influence on the nature of physical, chemical and biological soil as well as in turn provide a good influence on plant growth. According to Rosmarkam and Yuwono (2002) organic matter improving soil structurethus causing the soil to be light to be processed and easily penetrated by plant roots. Further explained that organic material can increase the cation exchange capacity of the soil so that the the soil's ability binds cations, becoming higher. As a result, if the soil fertilized with organic materials with high doses, the plant nutrients are not easily leached. On the other hand Mori (1986) mentioned that the soil which has a good structure has the ability to bind water and permeability well. Changes in the soil structure improvement will result in the improvement of plant roots and improve the yield and quality of plants. Noor (1996) said that the function of the organic matter in dry land farming is to increase the amount and stability in agreagat of soil, improving soil structure, increase the infiltration rate, and the storability of ground water, enriching nutrients in the soil and improving soil biological activities. In acid soils, organic fertilizer can increase soil pH (neutralizing Al by forming Al-organic complexes), and can improve the availability of micro-nutrients in the soil through a chelate of micro elements with the organic matter.

5. CONCLUSION

Effect of shade on upland rice varieties decreases the number of tillers, number of panicle, number of productive grains, production of grains per hill of plants and total sugar content of plants. Effect of organic matter on upland rice varieties increase number of panicle, number of productive grains, the production of grains per hill of plants and total sugar content of plants. Among the four varieties tested showed that the variety of Situ Patenggang provide better growth and production compared with other varieties (Si Kembiri, Situ Bagendit, and Tuwoti) in shaded conditions.

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