Effect of Soil Tillage Method, Organic Materials And Varieties On Growth And Production Of Upland Rice In The Area Of Immature Rubber Plantation

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Abstract: The problem of providing rice to feed the population of Indonesia nationally until now is still a problem for which need to be addressed.One alternative to be able to help overcome this problem is to develop the cultivation of upland rice in immature rubber plantations.This research aims to obtain an adaptive upland rice variety grown in immature rubber plantation with an appropriate soil tillage method and the optimal dose of organic matter to obtain high rice productivity.This research using split - split plot experimental design with 3 factors and 3 replications.The first factor is the soil tillage method consists of 3 methods (1.Soil cleaned with a hoe, then planted. 2.Soil tillage method 1 time with a hoe, flattened, then planted. 3.Soil tillage method 2 times with a hoe, flattened, then planted). The second factor is an organic material consists of treatment doses : 0 tons/ha, 5 tons/ha, 10 tons/ha dan 15 tons/ha. The third factor is the upland rice varieties (Si Kembiri and Situ Patenggang).The results showed that Situ Patenggang variety provide highly significant effect on the increase in the number of tillers and number of panicles per hill of plants compared to Si Kembiri variety. Organic material at dose of 5 tons/ha giving the highest significant effect to increase in the number of panicles per hill of upland rice crop. Combination of soil tillage method 2 times and Situ Patenggang variety giving the best significantly effect on increasing : the number of productive grain per panicle, grain weight per hill of upland rice plant and grain production per experiment plot. Combination of organic material at dose 5 tons/ha with Situ Patenggang variety giving best effect to the increased number of productive grain per panicle, grain weight per hill of upland rice plant, and grain production per experiment plot.

Keywords: immature rubber plantation, organic matter, rice varieties, soil tillage

1. INTRODUCTION

Provision of rice to meet national food needs in Indonesia today is still a problem that needs to be addressed. This is due to several constraints such as : population growth still high at around 2 % per year , a change of food consumption of the population from non - rice to rice, changes in agricultural land into non - agricultural, prolonged drought, flood hazards, delays planting time, the productivity of irrigated rice which is the main source of national rice has undergone leveling off. Changes in land use from agriculture to non- agriculture is a very important contributing factors, showed that there has been a change in wetland function to another sector with 1.6 million ha and the area of 1 million ha of which occurred in Java during the period 1981 to 1999 (Noor, 1996; Irawan et al 2001, Supijatno, 2003; Adiratma, 2004). If there is no new breakthroughs to overcome this problem, the Indonesian food needs will continuously import rice from other countries. While the availability of rice in the international market also has its limitations.

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As an illustration based on statistical data of 1998-2003, imports of rice to Indonesia ranges between 1.4 - 5.7 million tonnes per year (Biro Pusat Statistik, 2003). Therefore the problem of rice shortage is a national problem facing Indonesia is of course necessary to find an alternative solution of the problem. One potential alternative solutions that can be done is to make the development of upland rice cultivation as intercrops in immature rubber plantations. This area was used to allow the cultivation of upland rice to rubber plant reaches age 3-4 years (Stenway, 2003; Supijatno, 2003). The advantage of this area utilization in addition will be able to support the increase in national rice production in Indonesia, will also be able to improve the income and welfare of farmers who commercialize rubber crop and companies that develop plantation rubber crop both state and private enterprise. In addition, this way it will be able to intensify and make efficient the maintenance of the rubber crop before it produces rubber latex production. Thus the development of upland rice cultivation in immature rubber plantations will also support the strengthening of the development of rubber plantations in Indonesia. The total area of rubber plantations found throughout Indonesia today approximately 3.3 million ha in 23 provincial regions. Of the total area of the rubber plantations, rubber plantations owned by farmers covering an area of about 2.8 million ha (85%) where the number of rubber farmers were covered in it about 1.4 million households and the remaining 0.5 million ha (15%) are the state and private plantation companies. Every year about 3-4% is a new area of rubber plantation development (new replanting). This area can be utilized for the development of upland rice cultivation (Supijatno, 2003; BPS, 2004; Boerhandy and Agustina, 2008; Departemen Pertanian, 2006). Based on the above data, the potential of upland rice development in immature rubber plantations in Indonesia each year ranged 99,000 -132,000 ha. In addition, starting in 2006, the

Indonesian government has undertaken plantation revitalization program for the acceleration of the development of plantations owned by farmers through extension, rejuvenation and rehabilitation of rubber, oil palm and cocoa. The target of a revitalization program for rubber plantations, especially the first 5 years ahead is 300,000 ha (Ministry of Agriculture, 2006). From this program the potential availability of additional land for the development of upland rice in the rubber plantation area is of 60,000 ha each year. Thus, the potential for the development of upland rice cultivation in immature rubber plantations in Indonesia is quite large. In an effort to support the development of upland rice cultivation in immature rubber plantations in Indonesia is necessary to do a research on the growth and production of upland rice with trying to apply several soil tillage methods, varieties and application of organic manures in immature rubber plantations aged about two years. This research aims to obtain a best soil tillage method that can be applied in immature rubber plantations and the optimal doses of organic material on the cultivation of upland rice varieties with high productivity.

2. MATERIALS AND METHODS

2.1. Location of research

This research was carried out in a rubber plantation, village of Sei Putih, PT. Perkebunan Nusantara III in District Galang, Deli Serdang Regency, North Sumatra Province, Indonesia, in the area of immature rubber plantation by the age of two years. The location of this research is located at an altitude of 75 meters above sea level, flat topography with yellowish brown podzolic soil types (Dystrudept). The research was conducted from February to December 2009.

2.2. Materials and research tools

Materials and tools used in this research, include: upland rice seeds (*Si Kembiri* and *Situ Patenggang variety*), organic fertilizer derived oil palm empty fruit bunches, Urea, TSP, KCl, insecticides (Curater, Marshall 25 ST, Spontan 25 EC), the equipment of the hoe, kored, fork, sprayer, hand counter, tool of the meter, nylon nets, ropes of plastic, zinc, nails, bamboo, wood, paint, plastic buckets and camera.

2.3. Research design

This research uses experimental design of Split-Split Plot Design with three treatment factors, namely :

a. The first factor is soil tillage method as main plot treatment consisted of three levels:

1. P1 = Soil cleaned with a hoe, then planted
2. P2 = Soil tillage method 1 time with a hoe, flattened, then planted
3. P3 = Soil tillage method 2 times with a hoe, flattened, then planted

b. The second factor is the treatment of organic material as a subplot consisted of four dose level :

1. B0 = 0 tons / ha
2. B1 = 5 tons / ha
3. B2 = 10 tons / ha
4. B3 = 15 tons / ha

c. The third factor is the treatment of upland rice varieties as sub - sub plot treatments consisted of two types of varieties :

1. V1 = Varieties of Si Kembiri (local varieties of North Sumatra)
2. V2 = Varieties of Situ Patenggang

All experiment treatments consisted of 24 treatment combinations with three replications or blocks of experiment. So the total number of units of experiment there were 72 experimental plots and the number of plants there are 325 plants per plot with a sample of 5 plants per plot. Each experiment plot has a size of 5 m x 3.9 m, the distance between plots has a width of 0.5 m and the distance between the blocks there are 2 m. Spacing of upland rice in each experiment plot was 30 cm x 20 cm. The laying of experimental plots at the location experiment, carried out randomly. Randomization was performed in three phases: the first, randomization to the main plot, the second stage, the randomization is done at the subplot and the third stage, randomization to the subplot.

2.4. Implementation of research

In the conduct of research, the soil in each plot were treated according to the method of soil tillage treatments was previously set, then treated with organic matter by means evenly dispersed on each plot experiments in which dosage of organic materials applied according to a predetermined treatment. Then in each plot were seeded upland rice varieties, seven seeds in each planting hole with the planting depth of 3 cm. After the rice crop from the age of 7 days, then thinning the plants with the establishes in each planting hole, there are five rice plants which allowed to grow until the rice crop is harvested. Fertilizer application is done with the use of inorganic fertilizers Urea, TSP and KCl. Fertilizer of Urea as a source of nitrogen was applied at a dose of 200 kg urea / ha. Application of Urea performed three times. The first application was done two days before the rice seed is planted as much as 130 g urea/ experimental plots (1/3 of dosage) with the dispersed manner. The second and third nitrogen applications performed when the plants were 30 and 40 days after planting respectively of 130 g urea/plot (1/3 of dose), given by way of an array with a distance of 10 cm from the plant row. TSP as a source of phosphorus fertilization and KCl as a source of potassium, each given at a dose of 292.5 g TSP/plot (150 kg/ha) and 390 g KCl/ plot (200 kg/ha). Application is done only one time that is two days before planting in a manner spread over the experimental plots. Weeding in the area of the experiment carried out every two weeks once the manual way by using a hoe. The frequency of spraying insecticides to protect crops from plant pests carried out in accordance intensity of crop pests in the field. Insecticides used consisted of Curater, Marshall 25 ST, Spontan 25 EC with the recommended dose of each insecticide labels mentioned above. To protect of plants from pest attacks of the bird, then the plant area at the location of the experiment was closed with nylon plastic net, started when the rice plants enter the phase of grain filling to harvest ripe stage. Harvesting is done after the seeds of rice at panicle becomes yellow approximately 90% in each plot of the experiment. During the study, the parameters of plant growth and development were observed consisting of

parameters : number of tiller per hill of plants, number of panicles per hill of plants, number of productive grain per panicle, weight of grain per hill of plants and production of grain per plot of the experiment.

2.4. Analysis of data

Data from the 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 in the research in the area of immature rubber plantations is very significant affected by the variety and significant by interaction effect of soil tillage method and organic matter. Situ Patenggang variety has very significant effect on the increase of the number of tillers compared with Si Kembirii variety (See Figure 1). While the combination for the treatment of soil tillage method 2 times (P3) and a dose of organic matter 5 tons / ha (B1) give the highest effect on the number of tillers per hill of upland rice plants compared with the effect of combination treatment of soil tillage methods and doses of organic matter others (see Figure 2).

Figure 1
Effect Of Varieties On Number Of Tillers Per Hill of Upland Rice Plants

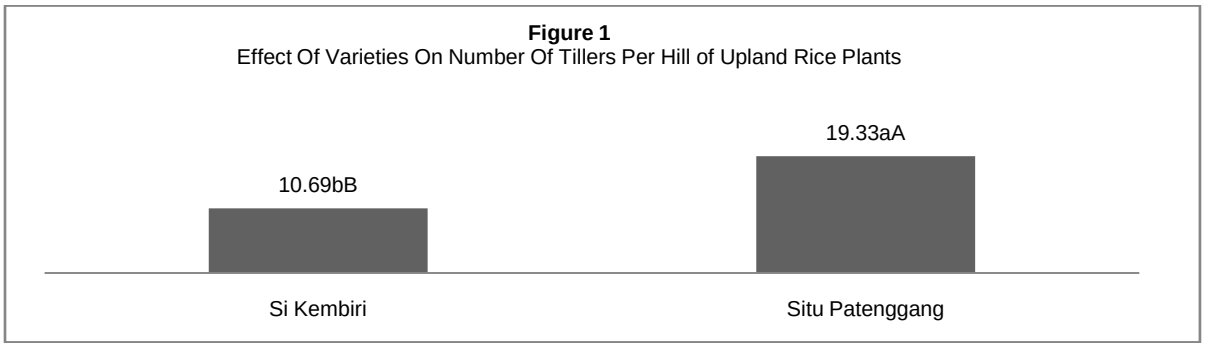
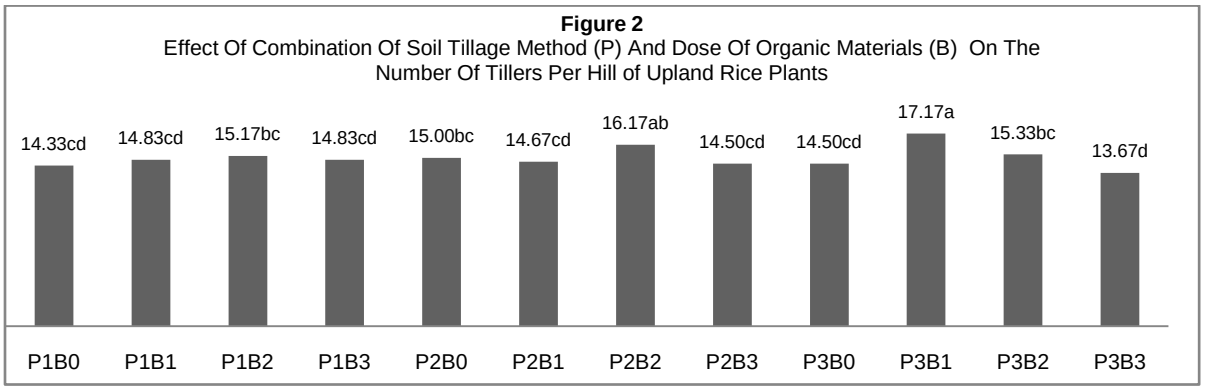


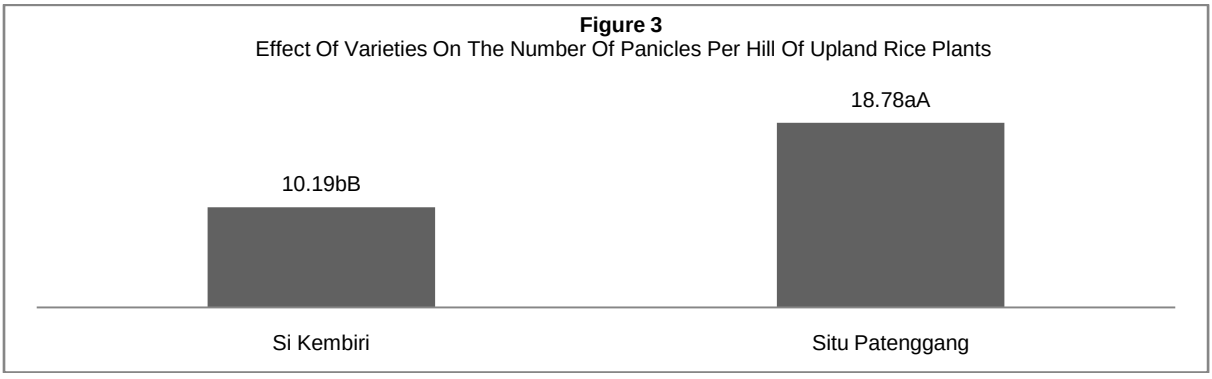
Figure 2
Effect Of Combination Of Soil Tillage Method (P) And Dose Of Organic Materials (B) On The Number Of Tillers Per Hill of Upland Rice Plants



3.2. Number of panicles

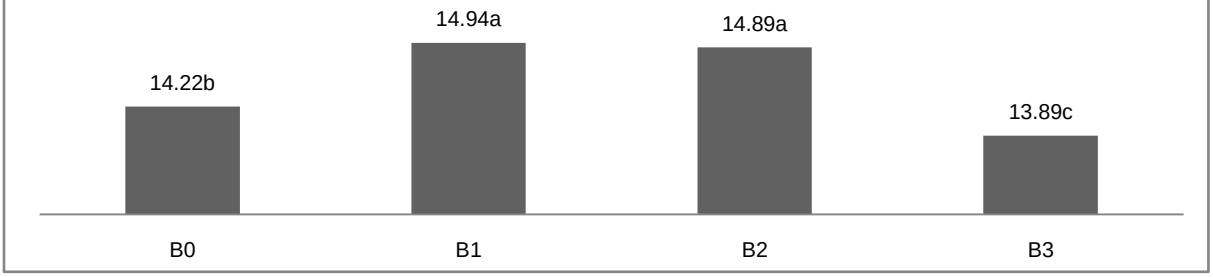
Treatment of varieties give very significant effect on the increase to the number of panicles per hill of upland rice plants, and the significant effect by the treatment of organic matter. Varieties that have the highest effect on the number of panicles found in variety of Situ Patenggang and was lowest for the variety of Si Kembiri (Figure 3).

Figure 3
Effect Of Varieties On The Number Of Panicles Per Hill Of Upland Rice Plants



On effect of the treatment dose of organic matter to the number of panicles per hill of plants, the highest number of panicles was found at a dose of 5 tons of organic matter/ha (B1) and it is higher than other organic materials dose treatment (Figure 4).

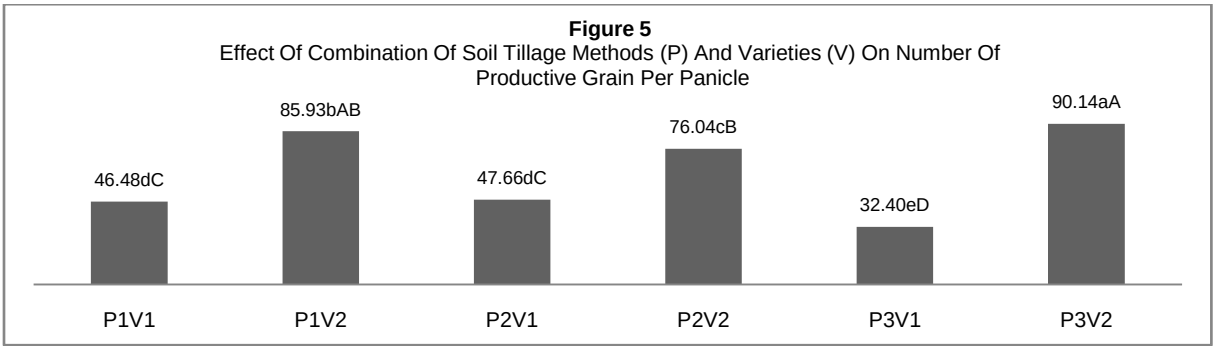
Figure 4
Effect Of Organic Materials Doses (B) On Number Of Panicles Per Hill Of Upland Rice Plants



3.3. Number of productive grain per panicle

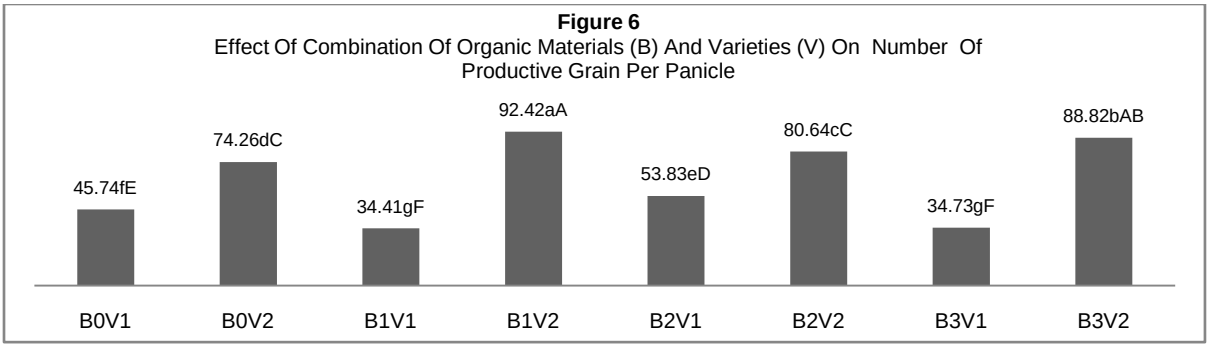
The amount of grain productive per panicle was very significantly influenced by the interaction of soil tillage methods and varieties, as well as by the influence of the interaction of organic materials and varieties. On the influence of the interaction of soil tillage methods and varieties, the amount of grain productive per panicle was highest in the combination of soil tillage method 2 times (P3) and variety of Situ Patenggang (V2) compared the effect of the combination of soil tillage method and other variety as shown in Figure 5.

Figure 5
Effect Of Combination Of Soil Tillage Methods (P) And Varieties (V) On Number Of Productive Grain Per Panicle



In the interaction effect of the doses of organic matter and varieties, the highest number of grain productive per panicle shown by the influence of the combination treatment of the dose of organic matter 5 tons / ha (B1) and varieties Situ Patenggang (V2) and it looks higher than the effect of treatment combinations of doses of organic matter and another varieties as it looks more complete data in Figure 6 below.

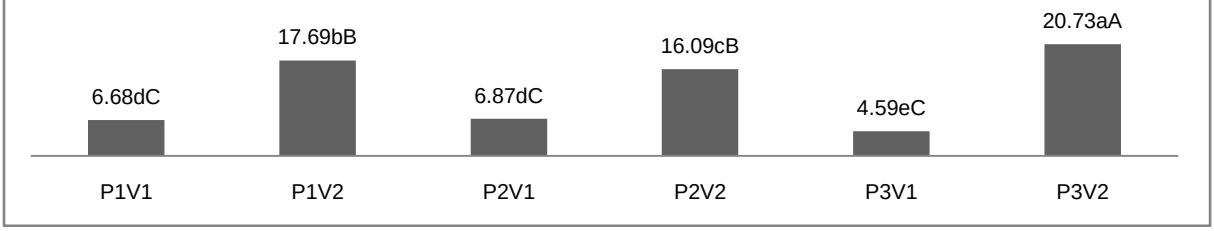
Figure 6
Effect Of Combination Of Organic Materials (B) And Varieties (V) On Number Of Productive Grain Per Panicle



3.4. Grain weight per hill of plants (g)

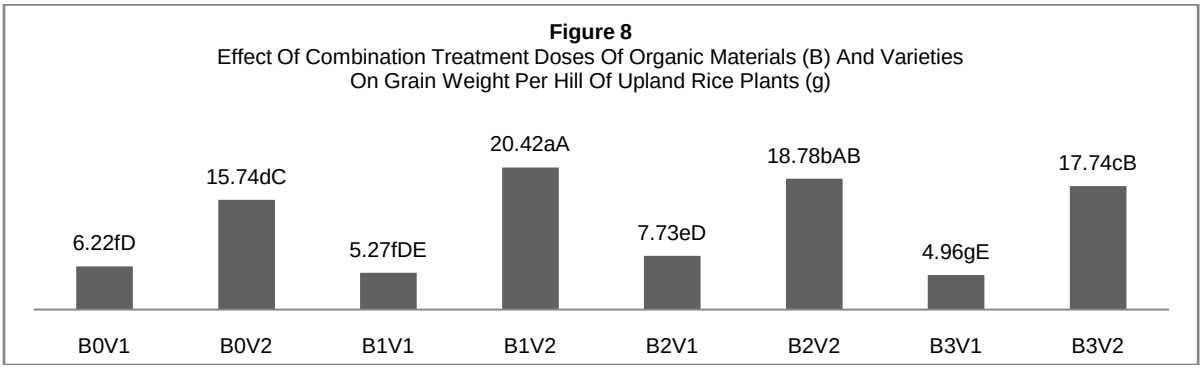
Grain weight per hill of upland rice plants was very signifcantly influenced by the interaction of soil tillage methods and varieties and, by effect of the interaction doses of organic matter and varieties. In effect of the interaction of soil tillage methods and varieties, grain weight per hill of upland rice which is the highest of all treatment combinations are shown by the effect of the combination treatment of soil tillage method 2 times (P3) and variety of Situ Patenggang (V2) (Figure 7).

Figure 7
Effect Of Combination Treatment Of Soil Tillage Methods (P) And Varieties (V) On Grain Weight Per Hill Of Plants (g)



In effect of the interaction dose of organic matter and variety, grain weight per hill of upland rice plants which are the highest shown at the combination treatment dose of organic matter at 5 tons/ha (B1) with the variety of Situ Patenggang (V2), compared with the treatment combination of the doses of material organic and other variety (Figure 8).

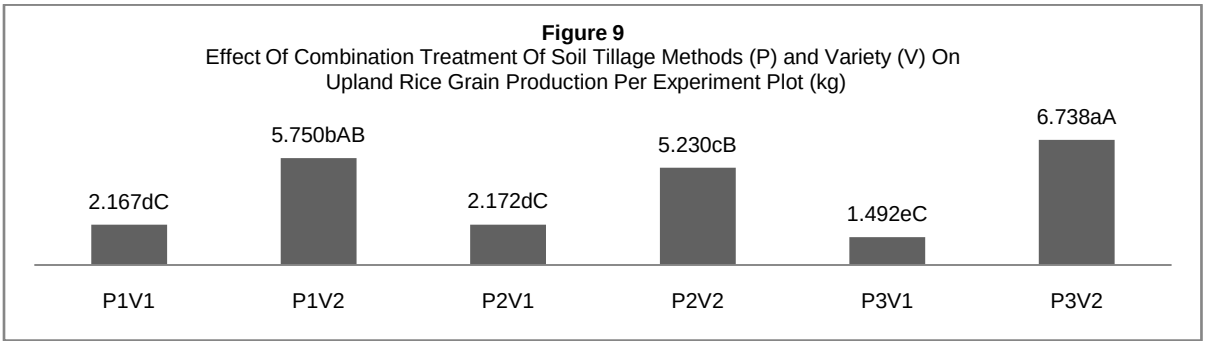
Figure 8
Effect Of Combination Treatment Doses Of Organic Materials (B) And Varieties On Grain Weight Per Hill Of Upland Rice Plants (g)



3.5. Grain production/experimental plot (kg)

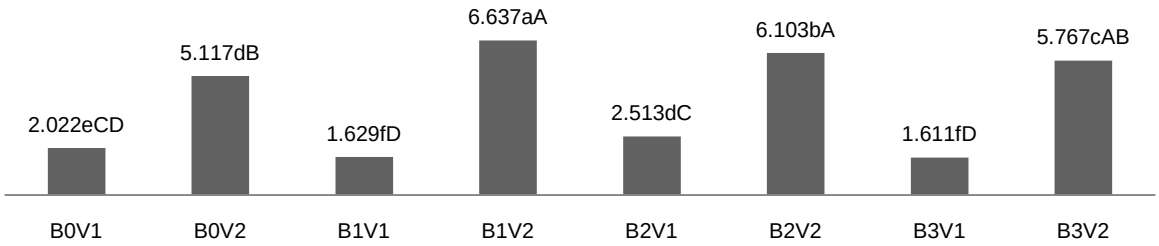
Production of upland rice grain per experiment plot were very significantlyl influenced by the interaction of soil tillage methods and varieties, and also influenced very significantly by interactions dosage of organic materials and varieties. In effect of the interaction of soil tillage methods and varieties, grain production is highest in the combination treatment of soil tillage method 2 times (P3) and variety of Situ Patenggang (V2) and it is higher than the combination treatment of soil tillage method and other varieties as seen in Figure 9 below.

Figure 9
Effect Of Combination Treatment Of Soil Tillage Methods (P) and Variety (V) On Upland Rice Grain Production Per Experiment Plot (kg)



In effect of the interaction doses of organic matter and varieties, grain weight was highest in the combination treatment dose of organic matter 5 tons/ha (B1) and variety of Situ Patenggang (V2) and it is higher than all treatment combinations doses of organic matter and other varieties. More complete data, we can see in Figure 11 below.

Figure 10
Effect Of Combination Treatment Doses Of Organic Materials (B) And Variety (V) On Upland Rice Grain Production Per Experiment Plot



4. DISCUSSION

Of the upland rice research in the immature rubber plantation area has been known that the treatment factor of varieties giving a very significantly effect on the increase in the number of tillers and number of panicles per hill of plants in which it appears that the variety of Situ Patenggang shows the number of tillers and panicles is higher than Si Kembiri variety (Figure 1 and 3).There are differences in the number of tillers and number of panicles between these two varieties were planted, presumably mainly due to the influence of genetic differences between the two varieties. Variety of Situ Patenggang showing the appearance of tillers and panicles growth is better. This is in line with what was said by Mangoendidjojo (2005) where it is mentioned that each variety is essentially has a composition or the genetic makeup of its own, so that in each variety has a variation or different properties compared to other varieties, both quantitative and qualitative nature. Treatment of the dose factor of organic matter in this research gives significant effect on the parameters of increase in the number of panicles per hill of upland rice plants with the provision of the highest dose of organic matter found in treatment of 5 tons/ha (Figure 4). It is known that organic matter can improve soil structure, causing the soil to become lighter to be processed and easily penetrated by plant roots (Rosmarkam and Yowono, 2002). Soil that has good structure has the ability to bind water and good permeability. Changes in soil structure improvement will result in improved conditions for plant roots and improve the quality and quantity of crop growth and yield, including growth in the number of panicles per plant (Mori, 1986). Titiek and Utomo (1995) explain that the structure of the soil affects plant growth through its effect on the development of roots and root physiology. Physiology of plant roots that is influenced by soil structure include nutrient absorption, water absorption and root respiration. Soil structure also affects the movement of nutrients in the soil, water movement and circulation of O2 and CO2 gas. Hardjowigeno (1986) and Sutanto (2002) stated that organic matter affects both the physical, chemical and biological soil as well as in turn gives a good effect on the growth and development of plants. Interaction of soil tillage methods and organic materials give significantly influence the growth and development of the number of upland rice tillers (Figure 2) where the combination treatment of soil tillage methods and doses of organic materials, the best is found in soil tillage method 2 times (P3) and doses of organic matter is 5 tons/ha (B1) (Figure 2). In general noted that soil tillage is needed to create good soil conditions for plant growth and development. Moenandir (2004) said that the soil tillage make the size of soil into smaller particles so that the surface of the soil which is more widely associated with plant roots. This situation allows plants to obtain nutrients is more than enough and resulted in the growth and development of plants to be good, including the number of tillers on the plant upland rice. According to Suhardi (1983) in the presence of soil tillage, the soil conditions would be better in terms of soil structure, soil porosity, the balance among the water, air and soil temperature so that the growth of the plants to be good in the planting area. Then soil tillage facilitating the use of a given nutrient in the soil by the plant, so the plant growth will be better. Furthermore, organic materials have been known to affect the soil properties (properties of the physical, chemical and biological soil) and plant growth (Hardjowigeno, 1986; Sutanto, 2002). Organic matter acts as a granulator which improves soil structure, sources of macro and micro nutrients on plant growth, increase the ability of soil to retain water and hold soil nutrients (cation exchange capacity of soil is high) as well as increased soil biological activities so that all plants can be better growing when given organic materials.Treatment interaction of soil tillage methods and varieties give highly significant effect on the amount of grain productive per panicle, grain weight per hill of plants and grain production/experimental plots. The treatment combination of soil tillage methods and varieties which is best found in the combination of soil tillage method 2 times (P3) and a variety of Situ Patenggang (V2) (Figure 5, 7, 9). Can be stated in general that each variety which tested both variety of Si Kembiri and Situ Patenggang give positive response to the parameters of growth and yield in the presence of soil tillage compared with no soil tillage. Better response shown by Situ Patenggang variety. It shows that the adaptive power of Situ Patenggang variety is better than Si Kembiri variety (V1) on the condition of soil tillage and environmental circumstances in this research. This is in line with what was stated by Mangoendidjojo (2005) that on each variety has its own genetic composition or arrangement, so that on each variety has a variation or different properties compared to other varieties of both qualitative and quantitative properties. Regarding the positive effect of tillage on growth and yield, among others expressed through : improved soil structure, porosity of the soil, the balance between water, air and temperature in the soil, and the surface of the larger soil particles can be associated with plant roots so that the growth and yield of crops would be good in the planting area (Suhardi, 1983 dan Moenandir, 2004). On the interaction of organic matter treatment dose and varieties provide a very significant effect on the amount of grain productive per panicle, grain

weight per hill of plants, and grain production per experimental plots. Combination treatment of the dose of organic materials and varieties, the best is found in combination treatment of the dose of organic matter 5 tons/ha (B1) and variety of Situ Patenggang (V2) (Figure 6, 8, 10). In this case also seen that factor of variety generally responded positively to the growth and development of the above parameters with the application of organic manures compared with the absence of organic matter. Response of Situ Patenggang variety was better than the local Si Kembiri variety (V1) on organic materials applied. It is of course also related to the differences in genetic factors between the two varieties tested (Mangoendidjojo, 2005). And for the organic material itself gives a good effect on growth and development and crop yield through improvements such as : soil structure, cation exchange capacity, soil pH, soil water retention power, the biological activity of soil, enriched soil nutrients, soil permeability, increasing the aggregate formation stable (Nakada, 1981 in Sutanto , 2002; Noor, 1996; Rosmarkam and Yowono, 2002).

5. CONCLUSION

Variety of Situ Patenggang provide highly significant effect on the increase in the number of tillers and number of panicles per hill of plants compared to Si Kembiri variety. Provision of organic material at dose of 5 tons/ha giving the highest significant effect to increase in the number of panicles per hill of upland rice crop. The treatment combination of soil tillage method and organic matter that is most significant to the improvement of upland rice tiller number found on the soil tillage method 2 times and doses of organic matter 5 tons/ha. Combination of soil tillage method 2 times and Situ Patenggang variety giving the best significantly effect on increasing the number of productive grain per panicle, grain weight per hill of upland rice plant and grain production per experiment plot. The treatment combination of organic material dose 5 tons/ha with Situ Patenggang variety giving best effect to the increased number of productive grain per panicle, grain weight per hill of upland rice plant, and grain production per experiment plot.

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