Potential of upland rice yield based on tillers and leaf area on various organic matter as the observation variables

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Abstract. The potential of upland rice production can be described through the parameters of the number of tillers and flag leaf area. This is supported on the optimal number of tillers forming the basis for grain formation, while the flag leaf area is an illustration of the potential assimilation that plants can produce. Provision of organic material in dry land is an alternative to increase the availability of ground water. The aim of this research was to study the relationship between variables, those were number of tillers, flag leaf area and grain production. The experimental method used was a Randomized Block Design (RBD) with 2 factors. Upland rice varieties were be the first factor, namely IPB 9G, IPB 8G, Sigambiri Merah, and Situ Patenggang. The second factor was organic materials: solid decanter, filter mud, oil palm empty fruit bunches, oil palm fibre, and cow manure. The results showed that upland rice had a greater number of tillers and wider leaves would produce higher production per plot. The provision of solid decanter could increase the number of tillers (51.56%), flag leaf area (35%), grain production per plot (55.12%) compared to the treatments without the provision of organic matter.

1. Introduction
Rice (Oryza sativa L.) is the only one widely used crop because the main source of food, and more than a third of the world's population uses it. More or less, in the amount of 11% is cultivated in the world. The development of upland rice is an alternative to increase national productivity because the efforts to increase paddy production of rice through intensification seem stagnant. Efforts to develop upland rice have a major obstacle, namely the availability of water. Upland rice cultivation is often faced with drought stress. The addition of organic material in upland rice cultivation is one of the efforts to improve the ability of soil to bind water. Provision of organic material will contribute to the growth and yield of rice.

Rice plants generally consist of shoots and main tillers whose growth time, pattern, and development differ depending on the time of their initiation [1]. The number of rice tillers has a large contribution in grain yield, and the level of contribution varies depending on the type of plant [2]. Rice production is very closely related to the number of tillers. Therefore, some agronomic efforts are made to determine the relationship between the number of tillers and grain yield. Changes in plant nutrient conditions or excessive number of tillers will result in decreased grain yield [3].
Leaf area is one of the important parameters in understanding photosynthesis, light interception, use of water and nutrients, and plant growth. Therefore, it is important to accurately measure plant leaf area for a better understanding of the relationship between rice development and the environment [4]. Plant growth and yield are significantly affected by leaf area through its effect on mild interceptions [5], critically affecting plant activities of metabolic, production of biomass, absorption and transpiration of CO₂. The relationship between leaf area and plant growth in terms of biomass formation will depend on how carbon is partitioned to other parts of the plant between new leaf area, mass of leaf, mass of root and respiration, also reproduction. There is a significant correlation between plant height, LAI and shoot biomass with the number, weight and grain yield. The correlation coefficient between these properties is more than 0.80 [6]. Leaf area index range is a function of the shoot plant [7]. Some researchers reported a positive correlation between leaf area index and other canopy functions [7].

Some researchers, namely Pal et al. [8] and Lopez [9] have conducted research and find a positive correlation between grain yields with parameters of effective number of tillers, spikelets and seed yield. Yields will further increase if there is an increase in irrigation water supply. Zorita reported her finding on a strong correlation between yield of wheat, tillers number and seeds number of panicles. Therefore, this study was conducted to study the parameter relationship of area of leaf and tillers numbers to upland rice yield with the addition of organic matter [10].

2. Materials and method
The study was conducted in an experimental field in Cengkeh Turi Binjai with a height of ± 32 meters above sea level, from August 2018 to January 2019. The materials used were upland rice seeds of 4 varieties namely, IPB 9G, IPB 8G, Sigambiri Merah, and Situ Patenggang. Organic matter added to the planting media were in the form of top soil, OPEFB, solid decanter, filter mud, oil palm fibre, and cow manure. This study uses a randomized block design (RBD) with two factors. The first factor was upland rice varieties namely (V₁) IPB 9G, (V₂) IPB 8G, (V₃) Sigambiri Merah, and (V₄) Situ Patenggang. The second factor was organic compounds, namely (P₀) without organic material, (P₁) solid decanter, (P₂) filter mud, (P₃) OPEFB, (P₄) Palm Oil, and (P₅) Cow Manure with a dose of 2 kg/plot on each. If there was a significant effect between treatments, then further testing was done using Duncan's multiple range test at α = 5%.

3. Results and discussion

3.1. Number of tillers
The results of the statistical analysis showed that the treatment of single factor, namely the provision of organic materials and types of variety affected the variable of the number of tillers, while the interaction of the two factors had no significant effect. The average number of tillers at 15 MST is shown in Table 1.

Situ Patenggang was the variety with the highest number of tillers, while rice given solid organic decanter also can make the highest production number of tillers. The results showed that rice without organic material can make the lowest production number of tillers. If the highest to lowest average of rice given organic material is sorted, then the arrangement is as follows: solid decanter, cow manure, filter mud, fibre, oil palm empty fruit bunches, and finally without the provision of organic material. The results of the soil analysis where the research conducted revealed that the soil pH was 4.9 and the C-organic content was 0.36 with very low criteria. This low level of C-organic resulted in nutrient availability. Decreased plant growth as a result of low pH [11]. The results of their discussion states that the low growth in acid soil is due to the low biomass produced. This low biomass results in insufficient energy for growth.

Chemical fertilizer offers easily soluble nutrients in soil solution and thus their availability in the soil is relatively higher than other fertilizer. Unlike the case of increased soil fertility, through the provision of organic material, nutrient availability is relatively slower. Provision of organic material
basically aims to increase soil microbial activity and improve soil physical properties. The availability of nutrients from organic material is influenced by microbial action and improvement in soil physical condition [12].

Table 1. Number of tillers of four rice varieties on organic material treatment

| Age          | Organic Material         | Variety         | Value | Unit | Criteria |
|--------------|--------------------------|-----------------|-------|------|----------|
| 15 MST       | P0 (Control)             | IPB 9G (V₁)     | 4.00  |      |          |
|              |                          | IPB 8G (V₂)     | 4.25  |      |          |
|              |                          | Red Sigambiri (V₃) | 3.75 |      |          |
|              |                          | Situ Patenggang (V₄) | 6.50 |      |          |
|              | 9G                       | Average         | 4.63 e |      |          |
|              | P1 (Solid decanter)      | IPB 9G (V₁)     | 10.00 |      |          |
|              |                          | IPB 8G (V₂)     | 6.75  |      |          |
|              |                          | Red Sigambiri (V₃) | 10.50 |      |          |
|              |                          | Situ Patenggang (V₄) | 11.00 |      |          |
|              | 10.50                    | Average         | 9.56 a |      |          |
|              | P2 (Filter mud)          | IPB 9G (V₁)     | 7.50  |      |          |
|              |                          | IPB 8G (V₂)     | 6.50  |      |          |
|              |                          | Red Sigambiri (V₃) | 10.50 |      |          |
|              |                          | Situ Patenggang (V₄) | 7.50 |      |          |
|              | 11.00                    | Average         | 8.00 abc |      |          |
|              | P3 (OPEFB)               | IPB 9G (V₁)     | 5.50  |      |          |
|              |                          | IPB 8G (V₂)     | 4.75  |      |          |
|              |                          | Red Sigambiri (V₃) | 6.00 |      |          |
|              |                          | Situ Patenggang (V₄) | 11.25 |      |          |
|              | 11.00                    | Average         | 6.88 bcd |      |          |
|              | P4 (Fibre)               | IPB 9G (V₁)     | 5.50  |      |          |
|              |                          | IPB 8G (V₂)     | 5.50  |      |          |
|              |                          | Red Sigambiri (V₃) | 6.25 |      |          |
|              |                          | Situ Patenggang (V₄) | 11.00 |      |          |
|              | 11.00                    | Average         | 7.06 bcd |      |          |
|              | P5 (Cow manure)          | IPB 9G (V₁)     | 9.25  |      |          |
|              |                          | IPB 8G (V₂)     | 7.75  |      |          |
|              |                          | Red Sigambiri (V₃) | 7.75 |      |          |
|              |                          | Situ Patenggang (V₄) | 10.50 |      |          |
|              | 11.00                    | Average         | 8.81 ab |      |          |

Note: Numbers followed by the same letter in the same column and row show no significant difference Duncan's Multiple Range Test at the level of α = 5%

The results illustrate that giving a solid decanter and following the cow manure produce the highest average number of tillers. The results of the chemical contents analysis of the solid decanter in Table 2 reveal that solid has high nitrogen nutrient content criteria while potassium is very high.

Table 2. Results of chemical content analysis of solid decanter

| Parameter     | Analysis Method             | Value | Unit | Criteria   |
|---------------|------------------------------|-------|------|------------|
| pH            | Electrometric               | 6.07  |      | Rather Sour|
| C-organic     | Walkley & Black             | 11.23 | %    | Very High  |
| C/N ratio     | -                            | 12.51 |      | Moderate   |
| N Total       | Kjehldahl-Spectrophotometry | 0.55  | %    | High       |
| P Total       | Spectrophotometry           | 0.06  | %    | Moderate   |
| K             | Photometric flame           | 0.24  | %    | Very High  |

Plants with sufficient potassium content have better growth compared to the others. Potassium is part of several enzymes that function as catalysts for chemical reactions in the body of plants. Potassium unites molecules with each other so that reactions of chemical can happen. Potassium is able to "activate" at least 60 with different enzymes involved in growth of plant. Potassium can be changes the physical form of enzyme molecules that expose the chemically active site to the reaction precisely. Potassium also neutralizes various of organic anions and other compounds in plants which help stabilize the optimal pH for most reactions of enzyme. The amount of potassium that is expressed in cells determines how many enzymes can be activated and the rate of chemical reactions can occur. Thus, the rate of a given reaction is controlled by the potassium rate to entering the cell [13].

3.2. Flag leaf area

The nutrients available in the solid decanter assisted rice in increasing the area of the flag leaf area, thereby producing higher photo-assimilation and more accumulation of dry matter [14,15].
Table 3. Flag leaf area of four rice varieties on organic material treatment

| Organic Material     | Variety              | Average   |
|----------------------|----------------------|-----------|
|                      | IPB 9G (V1)          | IPB 8G (V2) | Red Sigambiri (V3) | Situ Patenggang (V4) |          |
| P0 (Control)         | 69.50                | 68.51     | 39.62              | 35.06                | 53.17 b  |
| P1 (Solid decanter)  | 120.00               | 73.95     | 84.35              | 53.87                | 83.04 a  |
| P2 (Filter mud)      | 66.88                | 52.59     | 52.52              | 46.10                | 54.52 b  |
| P3 (OPEFB)           | 58.40                | 64.29     | 48.25              | 44.29                | 53.81 b  |
| P4 (Fibre)           | 58.22                | 62.01     | 46.33              | 46.48                | 53.26 b  |
| P5 (Cow manure)      | 68.07                | 76.08     | 61.06              | 47.25                | 63.11 b  |
| Mean                 | 73.51 a              | 66.24 ab  | 55.35 bc           | 45.51 c              |          |

Note: Numbers followed by the same letter in the same column and row show no significant difference in Duncan's Multiple Range Test at the level of α = 5%.

3.3. Grain production per plot
The results of this study indicated that Situ Patenggang was the variety having the highest number of tillers. The number of tillers to a certain extent indicates the potential for the formation of rice panicles, which are components of rice yield. The more the number of tillers components, the more grain production per plot. Waqar et.al. [16] also find a relationship between agronomic component and wheat yield. Some research results indicate that the number of tillers has a positive and significant correlation with a weight of 1000 g and grain yield per plant [17][18][19][20][21].

Table 4. Grain production per plot of four rice varieties on organic material treatment

| Organic Material     | Variety              | Average   |
|----------------------|----------------------|-----------|
|                      | IPB 9G (V1)          | IPB 8G (V2) | Red Sigambiri (V3) | Situ Patenggang (V4) |          |
| P0 (Control)         | 208.90               | 115.00     | 142.35             | 128.00                | 148.56 d |
| P1 (S. decanter)     | 340.65               | 263.15     | 325.15             | 395.30                | 331.06 a |
| P2 (Filter mud)      | 239.95               | 271.75     | 241.90             | 343.45                | 274.26 ab|
| P3 (OPEFB)           | 194.20               | 201.25     | 95.50              | 272.70                | 190.91 cd|
| P4 (Fibre)           | 138.15               | 177.10     | 92.10              | 272.35                | 169.93 d |
| P5 (Cow manure)      | 211.75               | 224.15     | 248.90             | 309.75                | 248.64 bc|
| Mean                 | 222.27 b             | 208.73 b   | 190.98 b           | 286.93 a              |          |

Note: Numbers followed by the same letters in the same column and row show no significant difference in Duncan's Multiple Range Test at α = 5%.

4. Conclusions
The provision of solid decanter could increase the number of tillers (51.56%), flag leaf area (35%), grain production per plot (55.12%) compared with the treatment without the provision of organic material. Situ Patenggang had the highest number of tillers, so its ability to produce production per plot is also higher than the two varieties.
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