The Effect of Organic Fertilizer in the Increasing of Local Upland Rice Production on Marginal Land in North Buton Indonesia

Budianti Kadidaa*, Gusti R. Sadimantaraa, Suaib2, La Ode Safuan2 and Muhidin2

1Postgraduate Program in Agriculture, Halu Oleo University, Kendari 93232 Southeast Sulawesi Indonesia.
2Department of Agrotechnology, Faculty of Agriculture, Universitas Halu Oleo, Kendari 93232 Southeast Sulawesi Indonesia.

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Demand for rice as a source of food in Indonesia continues to increase in line with the growth of population, while the capacity to produce paddy rice increasingly limited. One of the efforts is to develop upland rice by utilizing the dry land with organic fertilizer application. The research was conducted in North Buton using split plot design. The main plot was the treatment of manure dosage consisting of 4 levels of treatment and the second factor of local upland rice cultivars as a subplot consisting of 22 cultivars. Production characters were observed and assessments are panicle length, grain number, number of grain content, wet grain weight, dried grain weight, grain weight per culm, and grain yield (t ha\(^{-1}\)). The results showed that the yield potency of local upland rice cultivar in North Buton ranged from 3.11- 4.97 t ha\(^{-1}\) and the treatment of organic fertilizer can increase the yield components of upland rice.

Keywords: Upland rice, Progeny, Hybridization, Drought, Mineral stress.

Rice (\textit{Oryza sativa} L.) is the most important cultivation crop consumed around 97% of Indonesian population\(^1\). Rice should always be available in sufficient quantity, quality and affordable price\(^2\). Efforts to develop upland rice has been made by utilizing the dry land. Dry land in Indonesia is estimated to be 60.7 million hectares or 88.6% of dryland area, spread over wet climates with low nutrient, low productivity and dominated by ultisol soil. Dry land is potential for the development of upland rice\(^3\).

Dry land is dominated by acid soils, which are less favorable for plants due to low nutrient content, basic saturation and low cation exchange capacity (CEC), and high Al, Fe, and Mn concentrations. This condition will affect and inhibit crop production. Although ultisol productivity is low, it will respond well to appropriate management efforts, such as fertilization, calcification, and management of organic materials. Fertilization is a way to add nutrients needed by plants, especially nutrients N, P, and K, which are essential macro nutrients in addition to micro nutrients.

Fertilization is one of the decisive factors in increasing food production. The use of excessive inorganic fertilizer will increase the level of soil pollution\(^4\) that can ultimately affect human health. Therefore, it is necessary to find alternatives to overcome these problems, such as with the use of organic fertilizer, to increase rice productivity system, environmentally sustainable has maintained.

Organic fertilizer is a fertilizer material derived from living things, most of the organic
fertilizer in the form of solids such as manure and compost. Organic and manure materials are ingredients derived from plant or animal waste or by-products, such as cattle manure or poultry, composted rice straw or other crop residues, sewage on drains, cake, green manure and leguminous pieces.

Organic fertilizers play a significant role in creating soil fertility. The role of organic fertilizer is related to changes in the soil properties, i.e., physical, chemical, and biological properties of soil. The effect of organic matter on soil chemical properties among others on CEC, anion exchange capacity (AEC), soil pH, soil buffer power and soil nutrient properties. Microorganisms will decompose organic fertilizers in the soil into humus or soil organic matter. The decomposition rate of organic matter depends on the plants, plant age, chemical composition, aeration, temperature, humidity, fertility and climatic factors. The greatest role of organic fertilizer on soil physical properties includes structure, consistency, porosity, water binding capacity and equally important is the increase of resistance to erosion.

The effect of manure on crops has also been widely demonstrated to improve crop yields, beneficial to increased agricultural production in both quality and quantity, sustainably improving land quality. The results of the study on wet climates of dry land, the content of organic materials on ultisol can be maintained by applying recycling, namely the use of manure and agricultural waste. Long-term use of organic fertilizer can increase the land productivity and prevent land degradation, improve groundwater holding capacity, stabilize soil structure and increase soil nutrients. In rice cultivation on dry land, rice farmers do not fertilize, because the use of shifting cultivation model. In the pattern of permanent agriculture, the provision of fertilizer, especially organic fertilizer is needed. Therefore, this study aims to examine the potential yield and response of

| Cultivar (V)   | Panicle Length (cm) | Grain Number (kg ha⁻¹) | Number of grains / panicle | Wet Weight (g) | Dried Weight (g) | Weight Grain per Clump (g) | Grain Production (t ha⁻¹) |
|---------------|---------------------|-------------------------|---------------------------|----------------|----------------|------------------------------|--------------------------|
| Wakombe       | 38.19±c             | 121.31±g                | 107.53±d                 | 39.16±f        | 30.61±fg       | 48.80±de                    | 3.59±d                   |
| Wabalongka    | 41.84±a             | 141.76±b                | 134.85±a                 | 41.62±b        | 32.38±e        | 53.43±f                     | 4.23±b                   |
| Warumbia Merah| 36.12±f             | 120.45±g                | 107.01±f                 | 34.04±h        | 24.77±h        | 42.21±i                     | 3.16±h                   |
| Patiranga     | 35.95±b             | 123.72±c                | 111.20±a                 | 34.25±b        | 24.69±h        | 44.81±g                     | 3.33±s                   |
| Wa Apolo      | 40.50±b             | 154.42±e                | 147.00±d                 | 49.08±f        | 38.33±c        | 50.99±kd                    | 4.24±b                   |
| Kasakabari    | 36.99±e             | 121.60±d                | 107.50±f                 | 39.15±f        | 30.04±f        | 36.92±b                     | 2.80±s                   |
| Wangkaluku    | 38.28±f             | 116.27±g                | 103.30±d                 | 35.01±b        | 26.97±h        | 42.35±e                     | 3.15±k                   |
| Wangkariri    | 35.57±h             | 101.35±b                | 90.38±b                  | 34.20±h        | 25.65±g        | 47.01±df                    | 3.20±p                   |
| Warangka      | 39.89±h             | 125.73±f                | 117.39±d                 | 44.06±b        | 31.86±f        | 53.07±be                    | 4.53±j                   |
| Wabila Kambawa| 35.73±a             | 112.18±g                | 99.04±d                  | 31.01±f        | 22.62±d        | 43.68±h                     | 3.26±j                   |
| Wawondu       | 37.32±a             | 149.37±b                | 137.31±c                 | 53.80±e        | 44.88±h        | 56.65±e                     | 4.81±s                   |
| Wajini        | 37.94±h             | 102.64±b                | 89.34±d                  | 29.70±g        | 24.29±h        | 49.45±e                     | 3.23±j                   |
| Wawoni        | 37.19±h             | 124.02±f                | 111.00±e                 | 37.05±f        | 29.92±f        | 48.89±de                    | 3.80±p                   |
| Mantebeka     | 39.00±c             | 128.88±de               | 121.41±c                 | 51.49±b        | 35.49±d        | 51.27±be                    | 4.38±f                   |
| Wampogery     | 34.90±a             | 121.50±g                | 107.31±f                 | 31.16±h        | 25.38±i        | 46.05±f                     | 3.07±h                   |
| Wabila Lambale| 40.69±a             | 130.68±e                | 118.09±d                 | 50.60±d        | 39.44±f        | 52.07±e                     | 4.59±h                   |
| Warumbia Putih| 33.93±d             | 120.34±g                | 103.77±c                 | 33.91±h        | 24.77±h        | 50.23±e                     | 3.55±s                   |
| Waburiburi    | 31.69±g             | 119.90±f                | 105.10±e                 | 34.68±f        | 28.74±h        | 50.33±e                     | 3.68±s                   |
| Warara        | 39.55±a             | 132.50±g                | 123.70±c                 | 51.31±b        | 41.56±b        | 56.80±e                     | 4.65±h                   |
| Wankatama     | 36.37±f             | 123.27±f                | 111.26±a                 | 37.53±e        | 29.89±f        | 50.05±e                     | 3.52±s                   |
| Warena        | 36.57±h             | 123.37±f                | 111.26±a                 | 37.53±e        | 29.89±f        | 50.05±e                     | 3.52±s                   |
| Watanta       | 35.17±h             | 116.22±g                | 103.53±d                 | 26.62±h        | 20.99±g        | 50.59±bd                    | 3.37±m                   |

Remark: Means in the same suffixed in same line are not different at 5% level of significance according to DMRT.
Table 2. Effect of Organic Fertilizer on Generative Components of Upland Rice

| Parameter                  | Manure Dosage (P) | P0 | P1 | P2 | P3 |
|----------------------------|-------------------|----|----|----|----|
| Panicle length             |                   | 32.77d | 36.51c | 38.33b | 41.37a |
| Grain number               |                   | 111.12d | 120.13c | 126.40b | 135.11a |
| Number of grain content    |                   | 97.34d | 106.73c | 115.02b | 125.80a |
| Wet grain weight           |                   | 34.43d | 37.00c | 40.61b | 42.86a |
| Dried grain weight         |                   | 26.69d | 28.45c | 31.97b | 32.30a |
| Weight grain per clump     |                   | 41.56d | 48.63c | 53.50b | 51.75a |
| Grain production (t.ha⁻¹)  |                   | 2.75d | 3.40c | 4.26b | 4.41a |

Remark : Means in the same suffixed in same line are not different at 5% levels of significance according to DMRT.

MATERIAL AND METHODS

The research arranged using split plot design. The main plot was the treatment of manure dosage consisting of 4 levels of treatment and the second factor of local upland rice cultivars as a subplot consisting of 22 cultivars. The main plot is the difference of organic fertilizer dosage as follows: without organic fertilizer (P0), dosage of organic fertilizer 3 t.ha⁻¹ (P1), dosage of organic fertilizer 6 t.ha⁻¹ (P2) and dosage of organic fertilizer 9 t.ha⁻¹ (P3). While in subplot is the difference of cultivar of local upland from North Buton consist of 22 cultivars i.e., (V₁) = Wakombe, (V₂) = ultivar Wabalongka, (V₃) = Warumbia merah, (V₄) = Patirangga, (V₅) = Wa Apolo, (V₆) = Kasakabari, (V₇) = Wangkaluku, (V₈) = Wangkariri, (V₉) = Warangka, (V₁₀) = Wabila Kambawa, (V₁₁) = Wakawondu, (V₁₂) = Wajini, (V₁₃) = Wawonii, (V₁₄) = Mantebeka, (V₁₅) = Wampoguru, (V₁₆) = Wabila Lambale, (V₁₇) = Warumbia Putih, (V₁₈) = Waburiburi, (V₁₉) = Warara, (V₂₀) = Wankatema, (V₂₁) = Warema, (V₂₂) = Watanta.

RESULTS AND DISCUSSIONS

The results showed that there were differences in the character of local upland rice cultivars from the North Buton (Table 1), especially for the productive component of the plant. Based on the generative character, it appears that the highest panicle length is in Wabalongka cultivar. The maximum grain number and the largest number of grain contents is on Wa Apolo cultivar. The highest grain weight is in Wakawondu cultivar; The highest grain per clump is in the Warara cultivar, and The highest grain production is Wakawondu cultivars.

Analysis of variance showed that the treatment of organic fertilizer on local upland rice cultivars significantly affected the local upland rice yield components. The result revealed that the generative character is increased due to the treatment of biological fertilizer. The increase occurred are mainly on the parameters of panicle length, the grains number, the grain content number, the grain weight, the dry weight grain, the grain weight per clump, the weight of 1000 grains and the grain production (t.ha⁻¹).

The results showed that the dosage of organic fertilizer increase of upland rice yield component (Table 2). It included in the parameter of panicles length, grain number, the grain content number, wet grain weight, grain weight and grain weight (ton ha⁻¹). In general, the highest result obtained on components of treatment doses of manure 9 ton ha⁻¹. The results showed that the higher the dose, the more fertilizer increased plant growth.

The results of this study prove that the provision of organic materials can improve soil fertility so as to give effect to the improvement of local upland rice component growth. This is because organic matter is a source of nutrients N, P, and K. The contribution of organic matter to
planting growth is originated from its effect on the physical, chemical and biological properties of the soil. Organic matter acts as a nutrient addition of N, P, K for plants from mineralized microorganisms, transformation by microorganisms from an element of organic material into inorganic so available to the plant.

Nitrogen element plays an important role in stem elongation that occurs due to the process of cleavage, elongation, and enlargement of new meristematic of stems and leaves that cause the plant to grow taller\(^1\). Furthermore, it is explained that the administration of organic materials rich in N can increase chlorophyll, which can further enhance the photosynthetic rate of plants so that the accumulation of photosynthetic productivity is higher. The high accumulation of photosynthates results in enlargement and differentiation of cells expressed in the increase in height or length and addition of leaf size and area. Various research reports have proved that organic fertilizers can increase crop production because organic fertilizers are improving the physical, chemical and biological conditions of the soil thus providing conditions conducive to plant growth\(^2\). In addition, organic fertilizer in the process of decomposition can release nutrients slowly, so it can provide residual effects very useful for the next planting.

**CONCLUSION**

Based on the research concluded that the yield potency of local upland rice cultivar in North Buton ranged from 3.11- 4.97 t ha\(^{-1}\) and the treatment of organic fertilizer can increase the components of upland rice.

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