# Productivity of Two Rice Varieties Using Ratoon System Through N Fertilizing Treatments at Two Flooding Types on Tidal Lowland Area

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# Productivity of Two Rice Varieties Using Ratoon System Through N Fertilizing Treatments at Two Flooding Types on Tidal Lowland Area

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***Authors' contributions***

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

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## ABSTRACT

**Aims:** This research objective was to determine productivity of two rice varieties using ratoon system through regulation of N fertilizer application at two flooding types in tidal lowland area.
**Place and Duration of Study:** The study was conducted from February to July 2020 at two locations in tidal lowland area, i.e. B-type flooding located at $-2^0$3859, 132S $104^0$4428,449E and C-type flooding located at $-2^0$3858,81S $104^0$4426,745E in Mura Sugih Village, Tanjung Lago Subdistrict, Banyuasin District, South Sumatra, Indonesia.
**Study Design:** The experimental design used in this study was Factorial Randomized Block Design with two treatments factors and four replications. The variety treatments (V) were consisted of V1: Inpari 30 and V2: Hipa 5 Ceva. N fertilizer application treatments (A) were consisted of A1: N fertilizing: 1/3 dose at planting period + 1/3 dose at 42 dap + 1/3 dose at 1 day after harvest (dah) of main crop; A2: N fertilizing: 1/3 dose at planting period + 1/3 dose at 42 dap + 1/6 dose at 1 dah of main crop + 1/6 dose at 21 dah of main crop.
**Result:** The results showed that N fertilizer application regulation can increase productivity of two rice varieties using ratoon system at two flooding types land in tidal lowland area. Productivity of rice hybrid (Hipa 5 ceva) tend to be higher than that of rice inbred (Inpari 30) using ratoon system

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at two flooding types land in tidal lowland area. Productivity of two rice varieties using ratoon system tend to be higher at B-flooding type land than that of C- flooding type land.

*Keywords: Tidal lowland, productivity, N fertilizing, ratoon system, rice variety.*

## 1. INTRODUCTION

Ministry of Agriculture, Republic of Indonesia, targeting rice production in 2020 with magnitude of 3 ton per month in order to fulfill national average consumption of 2.5ton per month and as supply for national food security. One of efforts to fulfill this rice production target is through utilization of tidal lowland area. Tidal lowland is the one that is affected by high tide and low tide movement of seawater or river [1]. Based on high tidal water reach, then tidal lowland is classified as A, B, C and D flooding types [2,1]. Land with A-flooding type is overflowing by tidal water either during high tide or low tide period, whereas B-flooding type land is only overflowing during high tide period. Land with C-flooding type is not overflowing by high tidal water and its water table depth is less than 50 cm, whereas D-flooding type land is not overflowing by high tidal water but it has water table depth more than 50 cm. Farmers usually utilize tidal lowland for rice cultivation at B and C flooding types land.

Tidal lowland has several constraints consisting of continuous price increase of production facilities, lack of manpower and planting period that is highly depend on seasonal condition, low rice production due to high acidity of soil and relatively low availability of nutrients [3,4,5] as well as water flooding at some flooding-types of land [6]. Therefore, it is expected that those constraints can be overcome by using rice cultivation with ratoon system through proper fertilizer application and the use of adaptive rice varieties at several land flooding types. Rice cultivation with ratoon system is highly potential to be developed at tidal lowland area because apart from giving additional rice production, it also cost and labor saving as well as reduce harvest preparation time [7,8]. According to [9], ratoon technology is a new approach for farmers to produce more rice yield using lower land area, water and cost.

Fertilizer is one of inputs that have highly significant effect on the growth and yield of ratoon. Some studies showed that the growth of ratoon is highly depended on fertilizer composition, fertilizing time and fertilizer dose that are applied to main crop and ratoon crop, especially for N fertilizer [8]. According to [10,11], nitrogen fertilizing gives significant effect on the increase of rice crop production. The study result from [12] showed that nitrogen fertilizing with 1/3 dose given during planting time + 1/3 dose during primordial period + 1/3 dose given at harvest time tend to have good effect on ratoon rice yield.

The use of inbred and hybrid rice varieties is potential to be developed at tidal lowland area. These varieties are capable to produce ratoon, i.e. rice crop clump that had already been harvested and regrow to produce new tillers [7]. The study result from [12] showed that rice hybrid variety of Hipa 5 Ceva with ratoon system gave the highest rice yield with magnitude of 6.9 ton/ha. This study objective was to determine productivity of two rice varieties with ratoon system through through N fertilizing treatments at two flooding types on tidal lowland area.

## 2. MATERIALS AND METHOD

### 2.1 Plant Material and Seedling Preparation

Seeds used in this study are rice hybrid variety (Hipa 5 Ceva) and inbred variety (Inpari 30) in which both are potential to be developed and widely planted by famers at tidal lowland area. Seeds are previously incubated at room temperature in dark condition for 3 days [12] and after germinating they are sown on nursery beds having size of 2 m x 10 m.

### 2.2 Field Experiment

This study was conducted at tidal lowland area on tidal lowland area, i.e. B-type flooding located at -2$^0$38'59, 132"S 104$^0$44'28,449"E and C-type flooding located at -2$^0$38'58,81"S 104$^0$44'26,745"E in Mura Sugih Village, Tanjung Lago Subdistrict, Banyuasin District, South Sumatra, Indonesia.

### 2.3 Experimental Design and Procedures

The experimental design used in this study was Factorial Randomized Block Design with two treatments factors and four replications. The variety treatments (V) were consisted of V1: Inpari 30 and V2: Hipa 5 Ceva. N fertilizer application treatments (A) were consisted of A1: N fertilizing: 1/3 dose at planting period + 1/3 dose at 42 dap + 1/3 dose at 1 day after harvest (dah) of main crop; A2: N fertilizing: 1/3 dose at planting period + 1/3 dose at 42 dap + 1/6 dose at 1 day after harvest (dah) of main crop + 1/6 dose at 21 days after harvest (dah) of main crop. Land is cleared from the existing grasses and the crops residue by spraying with Paraquat herbicide and followed by soil tillage using moldboard plow which is drawn by tractor and then beds plot is made with size of 9 m x 3 m. Seeds having 21 days old are transplanted into each treatment plot (unit) with size of 9 m x 3 m which is previously added with manure at dose of 10 ton.ha$^{-1}$ and subsequently they are planted at upright position with planting distance of 25 cm x 25 cm, using 2 seeds per hole with 2 cm in depth according to Gribaldi's method [14]. N Fertilizer is given according to treatments, whereas P and K fertilizers are given to all treatment during planting period with dose of 60 kg per hectare, respectively. The main crop harvest is conducted by cutting the main trunk with height of 15-20 cm from soil surface according to Nakano et al. method [15]. Moreover, GA3 growth regulator at dose of 60 ppm is given to ratoon rice with once in 7 days interval starting from 3 days after cuuting of the main trunk up to before harvest. Harvesting of main crop or ratoon crop is done if the rice grains start to turn yellow and if rice grains when pressed feel hard.

### 2.4 The Measured Parameters

Observation of agronomic characteristics of rice crop at vegetative phase is consisted of: productive tillers per clump (tillers), total grains number per panicle (grains), empty grains percentage per panicle (%), and weight of 100 rice grains (g), rice grains yield per plot which is converted into rice grains yield per hectare (ton/ha), whereas rice productivity is calculated by accumulating rice yield of main crop (TU) and ratoon crop (R) per plot which is converted into per hectare (ton/ha).

### 2.5 Statistical Analysis

Agronomic characteristics data was analyzed statistically by using *Analysis of Variance* (ANOVA) followed by Tukey (HSD) test at significant level (α) of 5%. All data calculation was done by using SPSS 22.0 program and data was presented in form of tables and figures.

## 3. RESULTS

### 3.1 Soil Chemical Characteristics Prior to Treatment

Analysis results of chemical soil properties prior to treatment for two types of experimental plots showed that soil fertility levels either on C-type flooding or B-type lands was very low, soil pH was in the range of very acid to acid with pH values of 4.56 and 4,41, respectively. Alkaline content such as Ca, Mg and K-dd was in the range of very low to medium which indicate low nutrients availability in experimental land, especially total N nutrient content for two flooding types in tidal lowland is very low (Table 1). It is expected that addition of ameliorants in form of manure at dose 10 kg/ha and N fertilizer application can overcome nutrients availability problem and can increase rice crop yield.

### 3.2 Productive Tillers

Treatment of N fertilizer adjustment on two flooding-types in tidal lowland had significant effect on number of productive tillers for two rice varieties (Table 2).

N fertilizer application treatment: 1/3 dose at planting period + 1/3 dose at 42 dap + 1/3 dose at 1 day after harvest (dah) of main crop (A1) for rice hybrid variety of Hipa 5 ceva (V2) tend to produce more tillers number than other treatments either for the main crop and ratoon crop on two flooding-types in tidal lowland. This treatment was also had higher percentage of productive tillers number on ratoon rice crop (R) compared to main rice crop (TU) than other treatments with magnitude of 66.5 % for B-flooding type and 63.6 % for C-flooding type in tidal lowland.

### 3.3 Yield Components

Treatment of N fertilizer adjustment on two rice varieties had no significant effect on some yield components for main crop and ratoon crop at two flooding-types land in tidal lowland except for empty grain percentage on ratton crop. N fertilizer application treatment: 1/3 dose at planting period + 1/3 dose at 42 dap + 1/3 dose at 1 day after harvest (dah) of main crop for rice hybrid variety of Hipa 5 ceva (A1V2) produced the lowest empry grain with magnitude of 15.9 percent on B-type flooding, whereas the same treatment on C-type flooding produce empty grains with magnitude of 20.2 persen (Table 3.).

**Table 1. Results of soil analysis at two flooding types in tidal lowland area**

| Analysis | Results | | | |
|---|---|---|---|---|
| | C-type flooding | Criteria* | B-type flooding | Criteria* |
| N total (%) | 0.20 | Very low | 0.43 | Very low |
| pH | 4.56 | Acid | 4.41 | Very low |
| C-Organic (%) | 9.33 | Very high | 8.74 | Very high |
| Available P (ppm) | 32.14 | Very high | 37.34 | Very high |
| K-dd (me/100g) | 0.46 | Medium | 0.34 | Low |
| Na-dd (me/100g) | 1.97 | Very high | 2.15 | Very high |
| Ca-dd (me/100g) | 1.25 | Very low | 1.17 | Very low |
| Mg-dd (me/100g) | 1.11 | Medium | 1.06 | Medium |
| CEC (me/100g) | 24.86 | High | 23.01 | High |
| Al-dd (me/100g) | 0.40 | Low | 1.70 | Low |
| Texture (%) | | | | |
| -Sand | 11.08 | | 6.08 | |
| -Loam | 50.03 | | 55.10 | |
| -Clay | 38.89 | | 38.82 | |

*Source: Soil Science Laboratory, Faculty of Agriculture, Lampung University, Lampung. 2020. Criteria*: Soil Research Office, Bogor, 2009.*

**Table 2. Productive tillers of two rice varieties using several N fertilizing treatments at two flooding types site in tidal lowland area**

| Treatment | B-type flooding | | | C-type flooding | | |
|---|---|---|---|---|---|---|
| | TU | R | % R/TU | TU | R | % R/TU |
| A1V1 | 21.2 | 10.7 | 50.5 | 21.4 | 11.2 | 52.3 |
| A1V2 | 20.3 | 13.5 | 66.5 | 23.1 | 14.7 | 63.6 |
| A2V1 | 19.6 | 9.2 | 46.9 | 21.5 | 10.8 | 50.2 |
| A2V2 | 24.8 | 12.9 | 52.0 | 22.1 | 13.8 | 62.4 |

*A1: N fertilizing: 1/3 dose at planting + 1/3 dose at 42 dap + 1/3 dose at one day after harvest (dah) of main crop, A2: N fertilizing: 1/3 dose at planting + 1/3 dose at 42 dap + 1/6 dose at one day after harvest (dah) of main crop + 1/6 dose at 21 dah of main crop. V1: Inpari 30 and V2: Hipa 5 Ceva. R: ratoon; TU : main crop.*

**Table 3. Yield components of two rice varieties with N fertilizer application treatment at two flooding types in tidal lowland area**

| Treatment | Rice grains number per panicle (grains) | | | |
|---|---|---|---|---|
| | B-type flooding | | C-type flooding | |
| | TU | R | TU | R |
| A1V1 | 103.24 | 55.3 | 108.61 | 71.6 |
| A1V2 | 117.06 | 68.5 | 114.31 | 82.1 |
| A2V1 | 98.32 | 52.0 | 101.46 | 78.7 |
| A2V2 | 113.40 | 60.8 | 114.78 | 79.6 |
| **Treatment** | **Rice grain weight per 100 grains (g)** | | | |
| | B-type flooding | | C-type flooding | |
| | TU | R | TU | R |
| A1V1 | 2.4 | 2.1 | 2.8 | 2.1 |
| A1V2 | 2.4 | 2.1 | 2.6 | 2.4 |
| A2V1 | 2.4 | 2.1 | 2.6 | 2.2 |
| A2V2 | 2.5 | 2.1 | 2.8 | 2.2 |

| Treatment | Percentage of empty rice gains (%) | | | |
|---|---|---|---|---|
| | B-type flooding | | C-type flooding | |
| | TU | R | TU | R |
| A1V1 | 14.7 | 32.7d* | 15.3 | 35.1 |
| A1V2 | 14.9 | 15.9 a | 17.6 | 20.2 |
| A2V1 | 16.1 | 29.9 c | 17.3 | 30.2 |
| A2V2 | 21.4 | 22.6 b | 20.1 | 22.8 |

**Numbers followed by the same letter at the same column are not significantly different base on Turkey test at 5% level. A1: N fertilizing: 1/3 dose at planting + 1/3 dose at 42 dap + 1/3 dose at one day after harvest (dah) of main crop, A2: N fertilizing: 1/3 dose at planting + 1/3 dose at 42 dap + 1/6 dose at one day after harvest (dah) of main crop + 1/6 dose at 21 dah of main crop. V1: Inpari 30 and V2: Hipa 5 Ceva. R: ratoon; TU : main crop.*

**Table 4. Rice grain yield for main crop (TU) and ratoon (R) of two rice varieties at two flooding types in tidal lowland area**

| Treatment | B-type flooding | | | C-type flooding | | |
|---|---|---|---|---|---|---|
| | TU | R | TU+R | TU | R | TU+R |
| A1V1 | 4.4 | 1.9 | 6.3 | 3.8 | 2.5 | 6.3 |
| A1V2 | 4.6 | 2.8 | 7.4 | 4.2 | 2.9 | 7.1 |
| A2V1 | 4.5 | 2.6 | 7.1 | 4.0 | 2.7 | 6.7 |
| A2V2 | 4.3 | 2.9 | 7.2 | 4.0 | 2.8 | 6.8 |

*A1: N fertilizing: 1/3 dose at planting + 1/3 dose at 42 dap + 1/3 dose at one day after harvest (dah) of main crop, A2: N fertilizing: 1/3 dose at planting + 1/3 dose at 42 dap + 1/6 dose at one day after harvest (dah) of main crop + 1/6 dose at 21 dah of main crop. V1: Inpari 30 and V2: Hipa 5 Ceva. R: ratoon; TU : main crop.*

### 3.4 Rice Yield

N fertilizer application treatment: 1/3 dose at planting period + 1/3 dose at 42 dap + 1/3 dose at 1 day after harvest (dah) of main crop for rice hybrid variety of Hipa 5 ceva (A1V2) tend to produce higher rice grains for two rice varieties than other treatments either for the main crop (TU) or the ratoon crop (R) (Table 4). N fertilizer application treatment: 1/3 dose at planting period + 1/3 dose at 42 dap + 1/3 dose at 1 day after harvest (dah) of main crop for rice hybrid variety of Hipa 5 ceva (A1V2) tend to produce higher productivity (TU+R) for two rice varieties than other treatments with magnitude of 7.4 ton/ha for B-type flooding land and 7.1 ton/ha for C-type flooding land on tidal lowland area.

## 4. DISCUSSION

Ratoon system for rice cultivation can increase productivity due to rice yield addition obtained from ratoon rice. According to [16], the advantage of ratoon system application for rice cultivation can increase rice production per planting season with yield magnitude up to 40 – 60 percent from the main rice crop (TU). Moreover, fertilizer application treatment, especially nitrogen, can also increase rice productivity. N fertilizer application treatment: 1/3 dose at planting period + 1/3 dose at 42 dap + 1/3 dose at 1 day after harvest (dah) of main crop for rice hybrid variety of Hipa 5 ceva (A1V2) tend to have higher productivity than other treatments because application of N on the right dose and time will have effect on ratoon rice growth. According to [17,18], N nutrient application will affect tillers number which is subsequently will increase numbers and length of panicles. This is in accordance with the change of productive tillers obtained in this study in which N fertilizer application treatment: 1/3 dose at planting period + 1/3 dose at 42 dap + 1/3 dose at 1 day after harvest (dah) of main crop for rice hybrid variety of Hipa 5 ceva (A1V2) tend to have higher productive tillers than other treatments which in turn produce higher rice productivity than other treatments. Higher rice productivity from hybrid variety (Hipa 5 ceva) than inbred rice variety (Inpari 30) at the same N fertilizer treatment showed that hybrid variety is more adaptive than more efficient in utilizing the available resources. According to [19], hybrid variety has better growth than that of inbred variety. The study results by [20] showed that hybrid variety of Hipa 5 Ceva is variety which is adaptive and potential to be developed on tidal lowland area, either in B-flooding type and C-flooding type. Average productivity of two rice varieties on tidal lowland area in B-flooding type was higher than that of C-flooding type because water availability at B-flooding type is sufficient resulting in good process of rice grain filling which is indicated by lower average percentage of empty grains at B-flooding type than that of C-flooding type. Therefore, rice production at B-flooding type is higher than that of C-flooding type either for the main rice crop or ratton rice crop. According to [21,22], water shortage results in increase of empty grains number and decrease of rice grains weight. Moreover, [23] had stated that water is highly needed in crop growth process either for maintaining cells turgidity or crop metabolisms.

The optimal dose and time of nitrogen fertilization for the cultivation of rice and other crops in the tropics can vary widely according to weather conditions [24,25,26] and soil [27,28]. Based on research and field tests carried out more than ten years ago, the appropriate fertilization strategies were established for conventional rice plantings currently used in countries with a tropical climate, as well as in other crops such as corn [29], tomato [30], potato [31] and Onion [32].

## 5. CONCLUSION

The results showed that N fertilizer application regulation can increase productivity of two rice varieties using ratoon system at two flooding types land in tidal lowland area. Productivity of rice hybrid (Hipa 5 ceva) tend to be higher than that of rice inbred (Inpari 30) using ratoon system at two flooding types land in tidal lowland area. Productivity of two rice varieties using ratoon system tend to be higher at B-flooding type land than that of C- flooding type land.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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