Effect of new NPK fertilizer on lowland rice 
(Oryza sativa L.) growth

R Budiono1,*, P G Adinurani2 and P Soni3
1Assessment Institute for Agricultural Technology - BPTP Jawa Timur, Jl. Raya Karangploso km 4, East Java, Malang, 65101, Indonesia
2Faculty of Agriculture, Merdeka University of Madiun, Jl. Serayu No.79, Pandean, Madiun 63133, Indonesia
3Department of Agricultural and Food Engineering, Indian Institute of Technology Kharagpur, Kharagpur, West Bengal 721302, India

*Corresponding author: rohbudi68@yahoo.com

Abstract. Types of compound fertilizers in Indonesia and used for food crops were varied. At present, new NPK fertilizer has been produced with NPK composition of 15-15-15. To determine the level of effectiveness of new NPK fertilizer, new NPK fertilizer was applied on lowland rice (Oryza sativa L.) crops. The research was conducted at the Mojosari Research Station, Mojokerto Regency, Indonesia in the 2016/2017 Rainy Season. The materials needed in this study were: seeds of cv. Inpari 30, Urea, Phonska fertilizers and new NPK fertilizer that tested. The treatment consisted of eight fertilizer levels, consisting of one control (without fertilizer), one treatment recommendation, and six levels of new NPK fertilizer with composition 15-15-15. The research result showed that: i). New NPK fertilizer affects the growth and yield of rice plants, ii). The fertilizer dosage that provides the best response to vegetative and generative growth of rice plants is 250 kg ha⁻¹ of new NPK fertilizer + 300 kg ha⁻¹ Urea. This is supported by the value of relative agronomic effectiveness (RAE) of 101 % and economic feasibility (R/C ratio) of 1.88, and iii). New NPK fertilizer can be effectively used as an alternative to Phonska NPK fertilizer.

Keywords: Balance fertilizer, cv. Inpari 30, fertilizer efficiency, food security

1. Introduction
Rice farmers in Indonesia need efficient use of fertilizers to support food security programs and increase national rice production. Efficient fertilization is obtained from balanced fertilization, namely the application of fertilizer into the soil to achieve the status of all essential nutrients balanced and optimum in the soil. Balanced fertilization can increase production, improve the quality of agricultural products, fertilizer efficiency, soil fertility, and avoid environmental pollution. The combination of fertilization greatly affects the growth of rice plants [1].

Balanced fertilization does not have to be fertilizing using all types of fertilizers. Balanced fertilization is the provision of fertilizer into the soil to achieve the status of all nutrients in the soil and the optimum growing environment for plant growth and yield. The rational needs of N, P, and K fertilizers can affect the yield components of rice. Therefore, nutrients that have reached optimum need not be added anymore. So if the land has a high P and K status, then only a low dose of P and K
fertilizer is needed which is equivalent to P and K which is transported at the time of harvest. Source of nutrient can be in the form of single fertilizer, compound fertilizer or a combination of both [2].

Especially for cereal crops such as rice, corn, except NPK fertilizer, additional single Urea fertilizer is needed because N fertilizer (in this case Urea) should not be given at once but must be gradually two to three times. Giving Urea at the same time is very inefficient, most of ≥ 40% will be lost through various mechanisms in the soil [3].

Types of compound fertilizers in Indonesia and used for food crops include: (i) NPK fertilizer with NPK composition 15-15-15, (ii) NPK fertilizer with NPK composition 20-10-10, and (iii) NPK fertilizer with NPK composition 30-6-8 NPK content. At present, new type of compound fertilizer has been produced with NPK composition of 15-15-15. To determine the level of effectiveness of new type of an-organic fertilizer, the effectiveness of new type fertilizer on the growth and yield of lowland rice crops was tested.

2. Research methods

2.1. Research implementations

The research was conducted at the Mojosari Research Station, Mojokerto Regency, Indonesia in the 2016/2017 Rainy Season. The results of soil analysis before the study showed that the research location had a normal level of soil acidity (pH). The content of organic matter and macro nutrients is low except for high P and Ca so it is suitable for use in fertilizer testing (table 1).

| No. | Kinds of analysis | Value | Criteria |
|-----|------------------|-------|----------|
| 1.  | pH H2O           | 6.5   | Neutral  |
| 2.  | pH KCl           | 5.8   |          |
| 3.  | Organic matter (%) | 2.13 | Low      |
| 4.  | N–Total (%)      | 0.13  | Low      |
| 5.  | P–Olsen (mg kg⁻¹) | 18.0  | High     |
| 6.  | K–exchangable (me100 g⁻¹) | 0.29 | Low |
| 7.  | Ca– exchangable (me100 g⁻¹) | 13.58 | High |
| 8.  | Mg– exchangable (me100 g⁻¹) | 053  | Low      |
| 9.  | Na– exchangable (me100 g⁻¹) | 0.37 | Low      |
| 10. | Cation exchange capacity (me100 g⁻¹) | 21.34 | Moderate |

Source: Soil Laboratory of AIAT East Java.

The materials needed in this study were: seeds of cv. Inpari 30, Urea, Phonska fertilizers and new NPK fertilizer tested with NPK composition 15-15-15 (table 2). The tools needed were digital scales, rulers, and counters.

| Parameters                  | Unit | Value | Methods               |
|-----------------------------|------|-------|-----------------------|
| Nitrogen (N) content        | %    | 14.95 | Kjeldahl Destillation |
| P2O5 content               | %    | 15.96 | Spectrophotometec     |
| K2O content                | %    | 16.90 | Titrimetic            |

Continue on next page
2.2. Experimental design
The design used was Randomized Block Design (RBD) which was repeated three times. The treatment consisted of eight fertilizer levels, consisting of one control (without fertilizer), one treatment recommendation, and six levels of new NPK fertilizer with composition 15-15-15 (Table 3).

| Parameters          | Unit   | Value | Methods                     |
|---------------------|--------|-------|-----------------------------|
| Moisture content    |        | 50.60 | Drying oven at 75 °C        |
| Arsenic (AS) content| mg L⁻¹ | <0.01 | AAS                         |
| Cadmium (Cd) content| mg L⁻¹ | <1.00 | AAS                         |
| Mercury (Hg)        | mg L⁻¹ | <0.01 | AAS                         |
| Lead (Pb) content   | mg L⁻¹ | <1.00 | AAS                         |

Source: Sucofindo

2.3. Data analysis
The data obtained were analyzed for variance by the F test. If the F test shows a significant difference, then it is followed by the LSD test at the level of 5%. To find out the level of agronomy feasibility, an Relative Agronomic Effectiveness (RAE) was conducted. Calculation of the level of RAE (Relative Agronomic Effectiveness) is done by the formula:

\[
\text{RAE} = \left( \frac{\text{Yield at fertilizer that tested} - \text{Yield at control fertilizer}}{\text{Yield at standard level fertilizer} - \text{Yield at control fertilizer}} \right) \times 100\% \tag{1}
\]

Also carried out the feasibility analysis of farming / economic analysis (R/C ratio).

3. Result and discussion

3.1. Vegetative growth
The significant difference in plant height at 35 d of age is the effect of fertilizer application, whereas differences in plant height at age 49 DAP and 56 DAP are due to plants having gone through the peak growth of paddy nodes. Rice plant height growth peaks were reported in cv. Cibogo at plant age 42 DAP [4].
The differences based on the F test of 500 kg ha\(^{-1}\) Phonska + 300 kg ha\(^{-1}\) Urea were not significantly different based on the F test 1%. The number followed by the same letter in one column is not significantly different based on the 5 % LSD test, DAP = days after planting.

### Table 4. Plant height at (21, 35, 49, and 56) DAP.

| Treatment                                      | 21 DAP | 35 DAP | 49 DAP | 56 DAP |
|------------------------------------------------|--------|--------|--------|--------|
| Control                                        | 26.8 b | 42.1 c | 50.5 c | 51.1 c |
| Standart (250 kg ha\(^{-1}\) Phonska + 300 kg ha\(^{-1}\) Urea) | 30.5 ab | 51.9 a | 58.7 a | 60.5 ab |
| 250 kg ha\(^{-1}\) New NPK Fertilizer + 300 kg ha\(^{-1}\) Urea | 29.2 ab | 50.2 ab | 60.8 a | 61.2 ab |
| 150 kg ha\(^{-1}\) New NPK Fertilizer + 300 kg ha\(^{-1}\) Urea | 30.0 ab | 46.9 b | 58.3 a | 58.3 b |
| 300 kg ha\(^{-1}\) New NPK Fertilizer + 200 kg ha\(^{-1}\) Urea | 31.0 a | 48.7 ab | 53.3 b | 62.6 ab |
| 350 kg ha\(^{-1}\) New NPK Fertilizer + 100 kg ha\(^{-1}\) Urea | 30.8 a | 48.4 ab | 58.8 a | 63.4 a |
| 400 kg ha\(^{-1}\) New NPK Fertilizer + 50 kg ha\(^{-1}\) Urea | 30.5 ab | 49.0 ab | 59.3 a | 60.4 ab |
| 500 kg ha\(^{-1}\) New NPK Fertilizer | 30.3 ab | 46.8 b | 57.7 a | 59.2 ab |
| F test                                         | ns     | **     | **     | **     |
| CV %                                           | 7.66   | 4.68   | 4.20   | 4.87   |
| LSD 5 %                                        | 4.00   | 3.94   | 4.23   | 5.08   |

Description: * significant differences based on the F test 5 %, ** significant differences based on the F test 1 %, the number followed by the same letter in one column is not significantly different based on the 5 % LSD test, DAP = days after planting.

### Table 5. Average number of tillers in each treatment at age (21, 35, 49 and 56) DAP.

| Treatment                                      | 21 DAP | 35 DAP | 49 DAP | 56 DAP |
|------------------------------------------------|--------|--------|--------|--------|
| Control                                        | 5.2 b  | 10.8 b | 12.3 d | 13.1 d |
| Standart (250 kg ha\(^{-1}\) Phonska + 300 kg ha\(^{-1}\) Urea) | 5.9 ab | 19.1 a | 20.4 a | 21.7 a |
| 250 kg ha\(^{-1}\) New NPK Fertilizer + 300 kg ha\(^{-1}\) Urea | 6.4 ab | 19.3 a | 20.3 a | 20.5 ab |
| 150 kg ha\(^{-1}\) New NPK Fertilizer + 300 kg ha\(^{-1}\) Urea | 7.6 ab | 18.9 a | 20.1 a | 21.3 a |
| 300 kg ha\(^{-1}\) New NPK Fertilizer + 200 kg ha\(^{-1}\) Urea | 7.2 ab | 18.9 a | 19.3 ab | 21.2 a |
| 350 kg ha\(^{-1}\) New NPK Fertilizer + 100 kg ha\(^{-1}\) Urea | 6.8 ab | 18.4 a | 18.4 abc | 20.2 ab |
| 400 kg ha\(^{-1}\) New NPK Fertilizer + 50 kg ha\(^{-1}\) Urea | 7.9 a | 16.5 a | 16.9 c | 18.9 be |
| 500 kg ha\(^{-1}\) New NPK Fertilizer | 7.6 ab | 16.9 a | 17.7 bc | 18.1 c |
| F test                                         | ns     | **     | **     | **     |
| CV %                                           | 10.74  | 5.90   | 4.48   |
| LSD 5 %                                        | 3.47   | 1.15   | 1.00   |

Description: * there are differences based on the F test 5 %, ** there were differences based on the F test 1 %, the numbers followed by the same letter in one column were not significantly different based on the 5 % LSD test, DAP = days after planting.

The first and second fertilizers were the main factors in the growth of this plant's height.
The application of nitrogen increased from (120 to 190) kg N ha\(^{-1}\) increasing plant height significantly [5]. Nitrogen is a nutrient that is important for the growth of rice plants [6]. Plant height at 49 DAP and 56 DAP by treatment of 500 kg ha\(^{-1}\) New NPK Fertilizer can match with the standard treatment. Nitrogen in New NPK Fertilizer has been able to supply the needs of plants to growth in the final vegetative ie 49 DAP to 56 DAP (table 4).

Table 5 shows the average number of tillers at the age of 21 DAP. It did not show a significant difference between treatments. This was due to the application of the first fertilizer was carried out at the age of 14 DAP so that it only affects the green color of the leaves. The number of tillers affected by fertilization treatment was seen at 35 DAP, very significantly different between fertilizer treatment than without fertilizer (control). NPK fertilization and an-organic fertilization is one treatment that can increase the number of tillers [7]. The effect of fertilizer on plants aged 49 DAP and 56 DAP can affect production because the plants are willing to enter the generative period. According to [8] tillering begins around 2 wk to 3 wk after sowing. After reaching the maximum, the number of tillers decreases.

Table 5 showed that based on the number of tillers aged 49 DAP, fertilizing 150 kg ha\(^{-1}\) New NPK Fertilizer + 300 kg ha\(^{-1}\) Urea, 300 kg ha\(^{-1}\) New NPK Fertilizer + 200 Urea, 350 kg ha\(^{-1}\) New NPK Fertilizer + 100 kg ha\(^{-1}\) Urea, 400 kg ha\(^{-1}\) New NPK Fertilizer + 50 kg ha\(^{-1}\) Urea, and 500 kg ha\(^{-1}\) New NPK Fertilizer gave the same number of tillers as Standard treatment. The control treatment had significantly lower number of tillers compared to other fertilizers. N fertilization is a fertilizer treatment that can increase the number of tillers [2]. This showed that the fertilization given has been able to provide the same number of tillers as the needs of farmers in the field.

3.2. Yield components

Yield components that were influenced by fertilizer treatment were the number of panicles, panicle length, number of filled grains per panicle, weight of 1 000 seeds, and productivity. The amount of empty grains per panicle was not affected by fertilization treatment. NPK fertilizer in fertilizer treatment had a composition of 15 % for each element. The rational needs of N, P, and K fertilizers can affect the yield components of rice [2]. The number of empty grains per panicle was not significantly different in this study because the needs of KCl in plants were sufficient because the study was conducted in the rainy season. Potassium plays a role in regulating the closing of flowers in rice [9]. The condition of potassium sufficiency in rice resulted in the effect of flower closure being the same so that the panicle grain formed would be the same for each treatment including control plants.

3.2.1. Number of panicles and length of panicles. Table 6 shows the results of the analysis of variance on the average number of panicles with a very significant difference between fertilization treatments compared with no fertilization (control). The dose of 250 kg ha\(^{-1}\) New NPK Fertilizer + 300 kg ha\(^{-1}\) Urea, 150 kg ha\(^{-1}\) New NPK Fertilizer + 300 kg ha\(^{-1}\) Urea, 300 kg ha\(^{-1}\) New NPK Fertilizer + 200 kg ha\(^{-1}\) Urea, 350 kg ha\(^{-1}\) New NPK Fertilizer + 100 kg ha\(^{-1}\) Urea, 400 kg ha\(^{-1}\) New NPK Fertilizer + 50 kg ha\(^{-1}\) Urea, and 500 kg ha\(^{-1}\) New NPK Fertilizer gave the average number of panicles which were not significantly different from the standard treatment. The treatment of 500 kg ha\(^{-1}\) New NPK Fertilizer had an average number of panicles that it was lower than the standard treatment but higher than the control. This was illustrates that N provides an important role in the formation of panicles. The number of panicles shows the number of vegetative tillers that were productive tillers. The large number of panicles plays a large role in production because it had a high direct effect on yield [10]. Fertilizing a dose of 250 kg ha\(^{-1}\) New NPK Fertilizer + 300 kg ha\(^{-1}\) Urea, had been able to supply N, P and K elements that were the same as standard treatment so that the number of panicles formed can be the similar.
Table 6. Number of panicles and length of panicles.

| Treatment                                                      | Number of panicles | Length of panicles (cm) |
|---------------------------------------------------------------|--------------------|-------------------------|
| Control                                                      | 10.8 d             | 21.4 c                  |
| Standart (250 kg ha\(^{-1}\) Phonska + 300 kg ha\(^{-1}\) Urea) | 20.4 a             | 25.7 a                  |
| 250 kg ha\(^{-1}\) New NPK Fertilizer + 300 kg ha\(^{-1}\) Urea | 20.6 a             | 25.1 a                  |
| 150 kg ha\(^{-1}\) New NPK Fertilizer + 300 kg ha\(^{-1}\) Urea | 20.2 a             | 22.7 b                  |
| 300 kg ha\(^{-1}\) New NPK Fertilizer + 200 kg ha\(^{-1}\) Urea | 20.2 a             | 25.1 a                  |
| 350 kg ha\(^{-1}\) New NPK Fertilizer + 100 kg ha\(^{-1}\) Urea | 18.8 ab            | 25.7 a                  |
| 400 kg ha\(^{-1}\) New NPK Fertilizer + 50 kg ha\(^{-1}\) Urea  | 17.8 ab            | 25.7 a                  |
| 500 kg ha\(^{-1}\) New NPK Fertilizer                        | 16.5 b             | 25.6 a                  |

F test **
CV % 5.83 1.76
LSD 5 % 2.99 0.76

Description: * significant differences based on the F test 5 %, ** significant differences based on the F test 1 %, the number followed by the same letter in one column is not significantly different based on the 5 % LSD test.

The results of analysis of variance on the average panicle length did not differ significantly among the standard treatment (250 kg ha\(^{-1}\) New NPK Fertilizer + 300 kg ha\(^{-1}\) Urea), 300 kg ha\(^{-1}\) New NPK Fertilizer + 200 kg ha\(^{-1}\) Urea, 350 kg ha\(^{-1}\) New NPK Fertilizer + 100 kg ha\(^{-1}\) Urea, 400 kg ha\(^{-1}\) New NPK Fertilizer + 50 kg ha\(^{-1}\) Urea, and 500 kg ha\(^{-1}\) New NPK Fertilizer. Treatment of 250 kg ha\(^{-1}\) New NPK Fertilizer + 300 kg ha\(^{-1}\) Urea had a panicle length that similar with control and lower than standard treatment. Panicle length had moderate heritability [11], so that NPK fertilizer treatment had a large influence on panicle length because the panicle length was a variable that easily influenced by environment (table 6).

3.2.2. Average of number of grain filled and empty grain per panicles. The results of the variance analysis on the number of filled grain per panicle (table 7), showed a very significant difference between fertilization treatments compared to without fertilization. The dose of combination New NPK Fertilizer and Urea on the average number of grains filled per panicles showed no significantly different from standard treatment. The treatment of 500 kg ha\(^{-1}\) New NPK Fertilizer had a lower number of filled grain per panicle compared to other fertilizer treatments as well as standard treatment but higher than the control. This was because of nutrient content (N, P and K) contained in 500 kg ha\(^{-1}\) New NPK Fertilizer was still lower than in other fertilizing treatments so that seed filling was not optimal (table 3). More grain filled in the fertilizer treatment compared to the control due to the large number of prospective female flowers formed so that the grain filled formed can be higher (table 7).

3.2.3. Weight of 1 000 seeds. Table 8 shows the results of the variance analysis on the average weight of 1 000 seeds. The dose of 250 kg ha\(^{-1}\) New NPK Fertilizer + 300 kg ha\(^{-1}\) Urea, 300 kg ha\(^{-1}\) New NPK Fertilizer + 200 kg ha\(^{-1}\) Urea, 350 kg ha\(^{-1}\) New NPK Fertilizer + 100 kg ha\(^{-1}\) Urea, and 400 kg ha\(^{-1}\) New NPK Fertilizer + 50 kg ha\(^{-1}\) Urea the weight of 1 000 seeds had similar average weight of 1 000 seeds with standard treatment. Treatment of 150 kg ha\(^{-1}\) New NPK Fertilizer + 300 kg ha\(^{-1}\) Urea and 500 kg ha\(^{-1}\) New NPK Fertilizer had weight of 1 000 seeds lower than standard treatment. The weight of 1 000 seeds that equals with the standard treatment showed that the need for NPK fertilizer is
sufficient for rice plantations in the research locations (table 8). In addition, providing sufficient nitrogen fertilizer for plants, especially during the panicle formation, can increase grain weight [7].

**Table 7.** Number of grain filled and empty grain per panicles.

| Treatment                                              | Number of grain filled per panicles | Number of empty grain per panicles |
|--------------------------------------------------------|-------------------------------------|-----------------------------------|
| Control                                               | 91.3 c                              | 22.7 a                            |
| Standart (250 kg ha⁻¹ Phonska + 300 kg ha⁻¹ Urea)     | 128.2 a                             | 6.5 d                             |
| 250 kg ha⁻¹ New NPK Fertilizer + 300 kg ha⁻¹ Urea     | 131.6 a                             | 7.4 d                             |
| 150 kg ha⁻¹ New NPK Fertilizer + 300 kg ha⁻¹ Urea     | 128.5 a                             | 13.2 c                            |
| 300 kg ha⁻¹ New NPK Fertilizer + 200 kg ha⁻¹ Urea     | 130.6 a                             | 12.2 c                            |
| 350 kg ha⁻¹ New NPK Fertilizer + 100 kg ha⁻¹ Urea     | 131.2 a                             | 11.0 c                            |
| 400 kg ha⁻¹ New NPK Fertilizer + 50 kg ha⁻¹ Urea      | 130.5 a                             | 17.4 b                            |
| 500 kg ha⁻¹ New NPK Fertilizer                       | 106.5 b                             | 17.1 b                            |

F test  **
CV %  5.72  13.09
LSD 5 %  12.25  3.08

Description: * significant differences based on the F test 5 %, ** significant differences based on the F test 1 %, the number followed by the same letter in one column was not significantly different based on the 5 % LSD test.

**Table 8.** Average of 1 000 seeds weight on each fertilizer treatments.

| Treatment                                              | Weight of 1 000 seeds |
|--------------------------------------------------------|-----------------------|
| Control                                               | 24.1 c                |
| Standart (250 kg ha⁻¹ Phonska + 300 kg ha⁻¹ Urea)     | 25.2 a                |
| 250 kg ha⁻¹ New NPK Fertilizer + 300 kg ha⁻¹ Urea     | 24.9 ab               |
| 150 kg ha⁻¹ New NPK Fertilizer + 300 kg ha⁻¹ Urea     | 24.6 b                |
| 300 kg ha⁻¹ New NPK Fertilizer + 200 kg ha⁻¹ Urea     | 24.9 ab               |
| 350 kg ha⁻¹ New NPK Fertilizer + 100 kg ha⁻¹ Urea     | 24.8 ab               |
| 500 kg ha⁻¹ New NPK Fertilizer                       | 24.2 c                |

F test  **
CV %  1.10
LSD 5 %  0.37

Description: * significant differences based on the F test 5 %, ** significant differences based on the F test 1 %, the number followed by the same letter in one column is not significantly different based on the 5 % LSD test.

3.2.4. Yield of harvested dry grain. The results of analysis of variance of the production rates were significantly different on all the fertilizer treatment compared to without fertilizer (control). The highest average of grain yield was in the treatment of 250 kg ha⁻¹ New NPK Fertilizer + 300 kg ha⁻¹ Urea i.e 1 7.37 t ha⁻¹, but it was not significantly different from the standard treatment i.e 7.32 t ha⁻¹. This was due to the total nutrient content of N, P, K both treatments were similar, so that grain yield produced was similar (table 9). The lowest yield was at the treatment of 500 kg ha⁻¹ New NPK Fertilizer i.e 6.33 t ha⁻¹ but still higher than without fertilization (control). This showed that the nutrient adequacy of N, P and K had an important role in improving rice yield. According to [12], for
every ton of rice produced it took about 17.4 kg N, 2.6 kg P, and 14.5 kg K. The higher of the yield obtained, the greater of the nutrients needed and vice versa.

Table 9. Grain yield per hectare.

| Treatment                                                                 | Yield (t ha⁻¹) |
|--------------------------------------------------------------------------|----------------|
| Control                                                                  | 2.75 d         |
| Standart (250 kg ha⁻¹ Phonska + 300 kg ha⁻¹ Urea)                        | 7.32 a         |
| 250 kg ha⁻¹ New NPK Fertilizer + 300 kg ha⁻¹ Urea                        | 7.37 a         |
| 150 kg ha⁻¹ New NPK Fertilizer + 300 kg ha⁻¹ Urea                        | 6.58 bc        |
| 300 kg ha⁻¹ New NPK Fertilizer + 200 kg ha⁻¹ Urea                        | 6.75 bc        |
| 350 kg ha⁻¹ New NPK Fertilizer +100 kg ha⁻¹ Urea                         | 6.83 b         |
| 400 kg ha⁻¹ New NPK Fertilizer + 50 kg ha⁻¹ Urea                         | 6.90 ab        |
| 500 kg ha⁻¹ New NPK Fertilizer                                          | 6.33 c         |

**F test**

CV %  4.40

LSD 5 %  0.49

Description: * significant differences based on the F test 5 %, ** significant differences based on the F test 1 %, the number followed by the same letter in one column is not significantly different based on the 5 % LSD test.

3.3. Relative Agronomic Effectiveness (RAE) and Economic analysis (B/C ratio)

Table 10. The result of Relative Agronomic Effectiveness on new NPK fertilizer treatment on rice yield.

| Treatment                                                                 | Production (t ha⁻¹) | RAE (%) |
|--------------------------------------------------------------------------|---------------------|---------|
| Control                                                                  | 2.75                | -       |
| Standart (250 kg ha⁻¹ Phonska + 300 kg ha⁻¹ Urea)                        | 7.32                | -       |
| 250 kg ha⁻¹ New NPK Fertilizer + 300 kg ha⁻¹ Urea                        | 7.37                | 101     |
| 150 kg ha⁻¹ New NPK Fertilizer + 300 kg ha⁻¹ Urea                        | 6.58                | 84      |
| 300 kg ha⁻¹ New NPK Fertilizer + 200 kg ha⁻¹ Urea                        | 6.75                | 87      |
| 350 kg ha⁻¹ New NPK Fertilizer + 100 kg ha⁻¹ Urea                        | 6.83                | 89      |
| 400 kg ha⁻¹ New NPK Fertilizer + 50 kg ha⁻¹ Urea                         | 6.90                | 91      |
| 500 kg ha⁻¹ New NPK Fertilizer                                          | 6.33                | 78      |

3.3.1. Relative Agronomic Effectiveness (RAE). Fertilizers were declared to be agronomically effective if they have a relative agronomic effectiveness value of > 100 %. With a relative agronomic effectiveness value of > 100, it means that the fertilizer can increase yields greater than the increase in the yield of standard fertilizer on controls.

An organic fertilization with New NPK Fertilizer 250 kg ha⁻¹ + Urea 300 kg ha⁻¹ had a Relative Agronomic Effectiveness level of 101 %. This means that the application of New NPK Fertilizer 250 kg ha⁻¹ + Urea 300 kg ha⁻¹ could increase rice production by 1.01 times compared to the increase produced by control treatment (table 10).
3.3.2. Economic analysis (R/C ratio). Table 11 shows the results of the economic feasibility analysis of each treatment. From the eight fertilizer levels that all tried to provide profits of IDR 8 000 000 to IDR 14 000 000 with R/C ratios ranging from 1.51 to 2.00 except controls (without fertilizer) suffered losses of IDR 2 000 000 with R/C ratio of 0.82. The highest profit was on the combination of 250 kg ha\(^{-1}\) New NPK Fertilizer + 300 kg ha\(^{-1}\) Urea which i.e IDR 13 805 000 with an R/C ratio of 1.88.

**Table 11.** Analysis of rice farming at several doses of New NPK Fertilizer.

| Treatment | Yield (t ha\(^{-1}\)) | Production cost (IDR × 1000)** | Income (IDR × 1000)* | Benefit (IDR × 1000) | R/C ratio |
|-----------|-----------------------|-------------------------------|-----------------------|---------------------|-----------|
| Control   | 2.75                  | 13 480                        | 11 000                | 2 480               | 0.82      |
| Standart (250 kg ha\(^{-1}\) Phonska + 300 kg ha\(^{-1}\) Urea) | 7.32 | 14 625 | 29 281.3 | 14 656.3 | 2.00 |
| 250 kg ha\(^{-1}\) New NPK Fertilizer + 300 kg ha\(^{-1}\) Urea | 7.37 | 15 675 | 29 480 | 13 805 | 1.88 |
| 150 kg ha\(^{-1}\) New NPK Fertilizer + 300 kg ha\(^{-1}\) Urea | 6.58 | 15 025 | 26 333.3 | 11 308.4 | 1.75 |
| 300 kg ha\(^{-1}\) New NPK Fertilizer + 200 kg ha\(^{-1}\) Urea | 6.75 | 15 810 | 26 982.2 | 11 172.2 | 1.71 |
| 350 kg ha\(^{-1}\) New NPK Fertilizer + 100 kg ha\(^{-1}\) Urea | 6.83 | 15 945 | 27 311.1 | 11 366.1 | 1.71 |
| 400 kg ha\(^{-1}\) New NPK Fertilizer + 50 kg ha\(^{-1}\) Urea | 6.90 | 16 175 | 27 618.1 | 11 443.1 | 1.71 |
| 500 kg ha\(^{-1}\) New NPK Fertilizer | 6.33 | 16 730 | 25 336.7 | 8 606.8 | 1.51 |

Description: * Grain price IDR 4 000 kg\(^{-1}\) (dry grain), ** New NPK Fertilizer fertilizer price IDR 6 500 kg\(^{-1}\).

4. Conclusions

Based on the results of testing with New NPK Fertilizer in cv. Inpari 30 in Mojosari Research Station, it can be concluded that: i) New NPK Fertilizer affects the growth and yield of rice plants, ii) The fertilizer dosage that provides the best response to vegetative and generative growth of rice plants was 250 kg ha\(^{-1}\) New NPK Fertilizer + 300 kg ha\(^{-1}\) Urea. This was supported by the value of relative agronomic effectiveness (RAE) of 101 % and economic feasibility (R/C ratio) of 1.88, and iii) New NPK Fertilizer can be effectively used as an alternative to Phonska NPK fertilizer.

References

[1] Ramadhan F 2014 *Parameter Genetik Beberapa Varietas Padi (Oryza sativa L.) pada Kondisi Media Berbeda* [Genetic Parameters of Some Rice Varieties (Oryza sativa L.) in Different Media Conditions] [Bachelor’s Thesis] (Banda Aceh: Universitas Syiah Kuala) p 98 [in Bahasa Indonesia]

http://etd.unsyiah.ac.id/index.php?p=show_detail&id=3310

[2] Kasno A, Rostaman T and Setyorini D 2016 *Peningkatan produktivitas lahan sawah tadah hujan dengan pemupukan hara N , P , dan K dan penggunaan padi varietas unggul [Increasing productivity of rainfed area with N, P, and K fertilizers and use of high yielding varieties]* Jurnal Tanah dan Iklim 40(2) 147–57 [in Bahasa Indonesia]

https://www.neliti.com/id/publications/134900/peningkatan-produktivitas-lahan-sawah-tadah-hujan-dengan-pemupukan-hara-n-p-k-da

[3] Salikin K A 2003 *Sistem Pertanian Berkelanjutan* [Sustainable Agriculture System] (Yogyakarta: Kanisius) p 126 [in Bahasa Indonesia]

http://www.worldcat.org/title/sistem-pertanian-berkelanjutan/oclc/565830217

[4] Maulidya L 2015 *Studi Karakteristik Pertumbuhan Empat Varietas Padi (Oryza sativa L.) pada Tiga Ketinggian Tempat Berbeda* [Study of Growth Characteristics of Four Rice (Oryza sativa L.) Varieties in Three Different Altitude] [Bachelor’s Thesis] (Jember: Universitas Negeri Jember) p 4
EL-Batal M A, Abd EL-Gawad M H, Abdo FA, EL-Set A and EL-Aziz A 2004 Uniconazole application as anti-lodging for rice plants fertilized with high nitrogen rate Zagazig J. Agric., Res. 31 473–90
http://agris.fao.org/agris-search/search.do?recordID=EG2005000355

Noor M A 2017 Nitrogen management and regulation for optimum NUE in maize–A mini review Soil Crop Sci. 3(1) 1–9
https://www.cogentoa.com/article/10.1080/23311932.2017.1348214

Kadengkang I, Paulus J M and Lengkong E F 2015 Kajian pemanfaatan kompos jerami sebagai substitusi pupuk NPK pada pertumbuhan dan produksi padi sistem IPAT-BO Jurnal Bioslogos 5(2) 69–78 [in Bahasa Indonesia]
https://ejournal.unsrat.ac.id/index.php/bioslogos/article/download/10551/10138

Ahmad I, Mian A and Maathuis F J M 2017 Overexpression of the rice AKT1 potassium channel affects potassium nutrition and rice drought tolerance Journal of Experimental Botany 67(9) 2689–98
https://www.ncbi.nlm.nih.gov/pubmed/26969743

Totok A D H, Azis F N, Hidayat P, Susanti, D, Riyanto, A and Zheng S H 2014 Path coefficient analysis on G39 xCihering and mentik wangi xG39 rice in F4 generation Agrivita 36(1) 9–13
https://www.researchgate.net/publication/276393614_Path_coefficient_analysis_on_G39cihering_and_Mentik_WangiG39_rice_in_F4_generation

Yamin M 2015 Penentuan karakter sekunder di dataran menengah menggunakan path analysis [Determination of secondary character selection in plain medium using the path analysis] Jurnal Pertanian Berkelanjutan 4(1) 1–18 [in Bahasa Indonesia]
http://journal.uncp.ac.id/index.php/perbal/article/view/73

Dobermann A and T Fairhurst 2000 Rice: Nutrient Disorders and Nutrient Management (Makati: International Rice Research Institute) p 191
http://seap.ipni.net/article/SEAP-3015