

Ciherang Rice Agronomy Performance on the Balance of Nitrogen Intake from Azolla Compost and Urea

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ABSTRACT

Production of Ciherang Rice mainly planted in East Java decreased due to soil fertility decrease, especially Nitrogen nutrient as a result of intensive agriculture and excessive use of inorganic fertilizers. It was necessary to improve the soil fertility by using organic nutrient resources, particularly Nitrogen to balance the use of urea fertilizers. This research aimed to find the agronomic performance of Ciherang Rice on the balance of Nitrogen intake from Azolla and Urea fertilizers, conducted from March to June 2019 at Sulek Village, Tlogosari Sub-District, Bondowoso District, in ±510 m.a.s.l. The experiment used one factor RCBD, which was the balance of nitrogen intake of Azolla (A) compost and Urea (U) fertilizer, 10 treatment combinations, three replications. The result of followed-up DMRT test showed that the high performance was on a plant height at 56 (dap), the total number of tillers and productive tillers were affected by AU6 treatment (the balance of Azolla 12 g/m²: Urea 18 g/m²). The performance of wet weight of biomass was affected by AU8 (6 g/m²: 24 g/m²). Meanwhile, dry weight of biomass was affected by AU7 (9 g/m²: 21 g/m²). The performance of grain weight per clump was affected by AU4 (21 g/m²: 9 g/m²). Grain weight per plot was affected by AU5 (18 g/m²: 12 g/m²). The agronomic performance of Ciherang Rice approached its genetic potential, required small volume of Azolla, reduced the use of Urea fertilizer, and improved the soil fertility.

Keywords: Ciherang Rice, Nitrogen, Azolla Compost, Urea

1. INTRODUCTION

East Java is one of the rice barns in Indonesia apart from the Provinces of South Sumatra, West Java, Central Java and South Sulawesi. Since 2013, Ciherang varieties have been increasingly planted by farmers in East Java because the grain quality is good, the rice is fluffy, it is resistant to slopes, and it can be harvested fast [1]. Every year, East Java experience rice surplus to increase national rice stock. This is done to support Indonesia's food sovereignty efforts. Rice production in East Java is around 8.485 million tons per year, while the total consumption is 3.545 million tons with a consumption level of 91.26 kg per capita per year which tends to decrease to 88 kg per capita per year [2]. This rice surplus of 4.94 million tons per year is enough to be consumed by 43.3 million people of Indonesia with a rice consumption level of 114 kg per capita per year.

East Java's rice production surplus fluctuates every year, so it tends to affect the stability of national rice stock. This fluctuation is affected by harvested area and land productivity [3], as well as the perception and application of the concept of balanced fertilization by most of rice farmers who do not consistently refer to the site-specific nutrient management (SSNM) concept. The implementation of SSNM recommendations is able to save the total use of NPK inorganic fertilizers of 36.5% compared to the fertilization method used by farmers without reducing inbred rice yields, and increase the

efficiency of fertilizer use and the benefits of rice farming [4]. This shows that the implementation of SSNM recommendations in rice cultivation is technically feasible and economically profitable.

The growing environment, especially soils, greatly affects the growth and production of Ciherang rice. Farmers in East Java, especially in Ngawi and Jember applied more inorganic N fertilizer than SSNM recommendations [4]. This was also happening in Bondowoso, farmers implemented intensive agriculture by applying inorganic fertilizer that was not in accordance with SSNM recommendations and they had not applied the concept of integrated crop management (ICM). This agricultural practice was not conducive to increase the farm production and efficiency in a long term and it was not in accordance with the ICM concept. As a result, the fertility of Ciherang paddy fields experienced physical, chemical and biological decrease. This posed a long-term threat to farm efficiency and the continuity of Bondowoso as one of food barns in East Java. On the other side, Azolla plants were frequently found in rice fields in Bondowoso.

Azolla has the potential to be applied as organic fertilizer to reduce the pressure of using inorganic fertilizers while helping to improve the physical, chemical, and biological fertility of paddy soil. It is because the chemical content of Azolla has met the standards of organic fertilizer according to Minister of Agriculture Regulation No. 28 of 2009 [5]. Fertilization recommendations in the ICM concept including the use of N fertilizers must be consistent with the needs of plants and soil N conditions, the P and K contents of paddy soil must be always measured before adding something, composted organic fertilizer must be always added to improve the physical, chemical, and biological properties of the soil [6]. Azolla has been widely used as a

source of organic N in various forms to increase the growth and production of various kinds of plants while helping to improve physical, chemical, and biological soil fertility [7]. Application of Azolla fresh 5 ton ha⁻¹ on varieties kuroda carrot provided the highest result, better tuber shape, it was the result of tuber conversion from per m² to hectare, which was 34.09 ton ha⁻¹ [8]. The combination of 75% N fertilizer + Azolla compost and application of 25% N fertilizer + dry Azolla could optimize sweet corn production, made efficient use of inorganic N fertilizer, and increased soil fertility [9]. The combination of 50% inorganic N fertilizer and 50% fresh Azolla could increase the production by 29.31% compared to the treatment of 100% inorganic N fertilizer [10]. The use of Azolla as a 15 ton ha⁻¹ green fertilizer and Azolla as 30 ton ha⁻¹ compost had been able to increase the production of lowland rice almost as much as its potential production [11]. Azolla 6 ton ha⁻¹ compost fertilization showed 8.67 ton ha⁻¹ grain production with 89.62% higher grain content compared to the results of inorganic N fertilizer application of 8.09 ton ha⁻¹ with 86% grain content [12].

The results of the research above showed that Azolla was applied in the fresh, dried, and composted condition on Carrot, Sweet Corn, and Rice. In addition, fertilization with Azolla tended to replace inorganic fertilizers, so that it required large volumes of Azolla and it was difficult for farmers to procure it. The application of fresh Azolla was also less effective, because it cannot be used immediately for plants. However, Azolla in East Java, especially in Bondowoso, can be found easily because they grow in rice fields. Therefore, it is required a new and more practical thinking to use Azolla as a local potential to be a source of organic N to balance the excessive use of Urea fertilizer. The novelty of the results of this research is to use Azolla compost as a counterweight (not a substitute) for inorganic N fertilizer, so that it only needs as small volume of Azolla, reduces the amount of the use of Urea fertilizer, increases farming efficiency, and at the same time helps to improve soil fertility.

2. METHOD

The research was conducted in Sulek Village, Tlogosari Sub-district, Bondowoso District in ±510 meters above sea level (m.a.s.l), starting from March to June 2019. Materials used in this research included: Rice seeds of Ciherang variety, Azolla compost fertilizer, and urea fertilizer. The tools used included tractors and other plant cultivation tools as well as data collection tools. The research was conducted with a Randomized Complete Block Design (RCBD) consisting of one treatment factor, which was balancing the application of Azolla (A) Compost and Urea (U) fertilizer with 10 levels of treatment combination.

The treatment factor of balancing the application of N fertilizer between Azolla (A) compost and Urea (U) fertilizer:

- AU1: Azolla Compost 30 g/m² and Urea 0 g/m²
- AU2: Azolla Compost 27 g/m² and Urea 3 g/m²
- AU3: Azolla Compost 24 g/m² and Urea 6 g/m²
- AU4: Azolla Compost 21 g/m² and Urea 9 g/m²
- AU5: Azolla Compost 18 g/m² and Urea 12 g/m²

- AU6: Azolla Compost 12 g/m² and Urea 18 g/m²
- AU7: Azolla Compost 9 g/m² and Urea 21 g/m²
- AU8: Azolla Compost 6 g/m² and Urea 24 g/m²
- AU9: Azolla Compost 3 g/m² and Urea 27 g/m²
- AU10: Azolla Compost 0 g/m² and Urea 30 g/m²

The agronomic performance of Ciherang Rice was presented by observation data on agronomic variables including: the plant height, wet and dry weight of biomass, the number of total tillers and productive tillers, grain weight per plot, and grain weight per clump. And then the analysis of variance (ANOVA) was performed on the obtained data with F-test. The result of the analysis of variance found a significant difference and highly significant difference and it was tested further with DMRT at the level of 5%.

3. RESULTS AND DISCUSSION

The result of analysis of variance on the data from various observation variables on Ciherang Rice was found to be varied (Table 1.). Table.1 showed that the effect of balancing N nutrient between Azolla compost and Urea fertilizer was not significant difference on the plant height at 14, 28, and 48 days after planting (dap), but it was significant difference on the observation variable of wet and dry weight of biomass, the number of productive tillers, grain weight per clump, and grain weight per plot.

Table 1 Summary of the result of analysis of variance on all of observation variables

Observation variables	F-count	
1. Plant height at 14 (dap)	0,76	ns
2. Plant height at 28 (dap)	0,91	ns
3. Plant height at 42 (dap)	1,55	ns
4. Plant height at 56 (dap)	2,59	*
5. Dry Weight of Biomass	4,08	**
6. Wet Weight of Biomass	4,35	**
7. The number of total tillers	2,58	*
8. The number of productive tillers	4,42	**
9. Grain Weight/Clump	9,49	**
10. Grain Weight/Plot	3,73	**

Note:

- dap (days after planting)

- ns (no significant difference); *(significant difference); **(highly significant difference)

The result of further DMRT test on observation variables as indicator of Ciherang Rice performance showed that all combination of balancing Nitrogen fertilization was significant difference on AU1 (Table 2). The highest response of each observation variable on the treatment was different, except for the plant height, number of total tillers and number of productive tillers showing the highest response on treatment AU6. The lowest response was found on AU1 treatment, so there was significant difference on another combination of balancing fertilization.

The highest response from the variable of plant height was found in the treatment AU6 as well as the observation variable of number of total tillers and productive tillers. The combination of treatment AU6 was equal to 120 kg of Azolla compost or 700 kg of fresh Azolla and 180kg of Urea

fertilizer per hectare. The same response was also found on the variable of number of total tillers and productive tillers. The dose of 120kg of Azolla compost per hectare was lower from the dose applied by other researchers applying 30 ton ha-1 [11] and 6 ton ha-1 [12]. The absorption of Ciherang

Rice on inorganic N from the treatment AU6 that was only 180 kg per hectare also was lower than the dose of Urea fertilizer applied by farmers around the research site reaching 200 kg ha-1 and even more.

Table 2 Summary of the result of further DMRT test on all observation variables that was significant difference and highly significant difference

Observation variable, Treatment, Mean, and Notation of the result of further DMRT test						
Plant Height	Wet Weight of Biomass	Dry Weight of Biomass	Number of Total Tillers	Number of productive tillers	Grain Weight/plot	Grain Weight/clump
AU6: 85,58a	AU8: 113,75a	AU7: 64,42a	AU6: 25,17a	AU6: 17,67a	AU5: 326,33a	AU4: 17,33a
AU5: 84,92ab	AU4: 112,67ab	AU10: 64,42a	AU9: 24,42ab	AU9: 17,17ab	AU3: 303.00ab	AU10:17,17ab
AU4: 84,92ab	AU9: 112,00ab	AU3: 63,42ab	AU5: 23,67abc	AU5: 16,83ab	AU10: 281,33ab	AU3: 17,08ab
AU9: 84,75ab	AU10:110,75ab	AU8: 60,08abc	AU10: 23,33abc	AU10: 16,83 ab	AU4: 278,00ab	AU9: 16,75abc
AU7: 84,75ab	AU7: 110,75ab	AU9: 57,50abcd	AU7: 22,83abc	AU7: 15,75abc	AU7: 275,33ab	AU8: 16,67abc
AU8: 84,33ab	AU3: 110,00ab	AU2: 56,70abcd	AU4: 22,58abc	AU8: 15,25abc	AU2: 269,00ab	AU5: 16,25abc
AU3: 84,08ab	AU6: 106,92ab	AU4: 55,92bcd	AU3: 22,25abc	AU4: 14,58bc	AU8: 236 .00b	AU7: 15,92 bc
AU2: 83,33ab	AU2: 106,58ab	AU6: 53,08cd	AU8: 21,92bc	AU3: 14,42bc	AU6: 233,00 b	AU2: 15,58 c
AU10: 82,75b	AU5: 105,00b	AU5: 49,83d	AU2: 21,00b	AU2: 13,58 c	AU9: 218,67 b	AU6: 15,50 c
AU1: 80,83c	AU1: 96,083c	AU1: 49,17e	AU1: 19,08 c	AU1: 10,92 d	AU1: 134,67 c	AU1: 12,75 d

Note: Numbers followed by the same lowercase in one column shows no significant difference on Duncan’s multiple range at the level of 5%.

The highest response from the variable of wet weight of biomass was found on AU8 treatment with the application of Azolla compost of 60 kg ha⁻¹ and Urea fertilizer of 240 kg ha⁻¹. It was slightly different from the highest response from the dry weight of biomass that was found on AU7 treatment with the application Azolla compost of 90 kg ha⁻¹ and Urea fertilizer of 210 kg ha⁻¹. These both of observation variables were vegetative phase product that absorbed a lot of N nutrient, on the other hand, the dose of urea fertilizer in both of treatments was high, and so it was more available for plants.

Another performance indicator of Ciherang Rice was grain weight per plot showing the highest response in AU5 treatment, while grain weigh per clump showed the highest response in the AU4 treatment. The AU5 treatment applied Azolla compost of 180 kg ha⁻¹ and Urea fertilizer of 120 kg ha⁻¹, while AU4 treatment applied Azolla compost of 210 kg ha⁻¹ and Urea fertilizer of 90 kg ha⁻¹. These two variables were physiologically active in the generative phase of Ciherang Rice plant, so the presence of Azolla compost with the rate of organic N availability that was slower than its inorganic N availability was expected to provide contribution on the highest absorption from the two variables.

The performance of Ciherang Rice in this research was affected by the balancing pattern of organic N fertilizer from Azolla compost and inorganic N from Urea fertilizer. Each reduction in Urea fertilizer dose was followed by the increase in Azolla compost dose, so the N supply for Ciherang Rice remained fulfilled. The highest response from all observation variables cannot be found from the

maximum dose of fertilizer from these two N resources. It showed that in the land condition in Bondowoso, the substitution of N fertilizer source from inorganic to organic or vice versa was not effective because the fertility of Ciherang paddy fields experienced physical, chemical and biological decrease. Therefore, the concept of balancing N fertilization between Urea fertilizer and Azolla compost was the most suitable method to be performed today.

4. CONCLUSION

Azolla compost was effective as counterweight of Urea fertilizer for the growth and development of Ciherang Rice. Azolla compost was applied as a counterweight not a substitute for Urea fertilizer. Azolla compost increased the nitrogen nutrient and improved the physical, chemical, and biological soil fertility. The performance of Ciherang Rice in agronomical had already closed its genetic potential.

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