

The effectiveness of organic and inorganic fertilizer on growth and yield of rice (*Oryza sativa* L.) in paddy field

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Abstract. The experiment was aimed to investigate the effectiveness of organic and inorganic fertilizer combination on the performance of rice. The research was designed in RBD, 3 replicates, and 8 treatments. The first factor was the combination of organic and NPK fertilizer that consisted of A = no added fertilizer, B = 200 Urea ha^{-1} + 300 kg NPK Phonska ha^{-1} (Recommended Rates of Inorganic Fertilizers or RRIF), C = RRIF + 2 tons organic fertilizer ha^{-1} , D = RRIF + 4 tons organic fertilizer ha^{-1} , E = RRIF + 6 tons organic fertilizer ha^{-1} , F = 50% RRIF + 2 tons organic fertilizer ha^{-1} , G = 50% RRIF + 4 tons organic fertilizer ha^{-1} , and H = 50% RRIF + 6 tons organic fertilizer ha^{-1} . Data analysis used ANOVA (*Analysis of Variance*) and followed by Duncan's Multiple Range Test 5%. The results showed that the application of RRIF + 6 tons organic fertilizer ha^{-1} obtained of grain yield of rice 7.65 tons ha^{-1} (increased of 18.24%) from the RRIF, R/C-ratio 2.17, and B/C-ratio 1.86. Fertilizers treatment E = RRIF + 6 tons organic fertilizer ha^{-1} showed it effectiveness with effectiveness of 150,21% (RAE > 100%).

Key words : Organic fertilizer, inorganic fertilizer, growth, yield, paddy field

1. Introduction

Rice (*Oryza sativa* L.) is an important cereal crop of the poaceae family and a major staple food that is widely consumed all over the world irrespective of race, religion and political association [1]. To assure food security in the rice consuming countries of the world, farmers must produce more rice of better quality to meet the demands of consumers in coming years [2]. However, the average yield of rice has been stagnant and remained lower than the production potential, which might be due to imbalanced use of fertilizers. Excessive or inappropriate use of chemical fertilizers (CFs) is a major cause of nutrient imbalance in soil, leading to high losses, particularly of N from the fertilizer, low N recovery (30%) [3] and low N use efficiency (about 35%) [4] in rice.

The rice plant (*Oryza sativa* L.) as a producer of rice has an important meaning for the majority of the Indonesian population because rice is the main food ingredient. Based on data from the Central Statistics Agency [5], rice production in 2018 was 32.42 million tons with rice consumption reaching 33.47 million tons. The higher consumption of rice compared to rice production in Indonesia is a food problem that is of great concern. So it is necessary to make efforts to increase rice production. To increase rice production, a rice planting intensification program was carried out, one of which was fertilization [6].

Increasing food demand in the last few decades due to the increase of earth population influenced the management of agricultural activity. As consequences, intensive agricultural activities by implementing excessive inorganic fertilizer and mechanization were suspected create problem on both environment and agricultural farmland. Therefore, to avoid the degradation of the environment and agricultural soil proper strategy in practicing agriculture should be taken into account [7].

Organic matter plays an important role in increasing soil fertility. The function of giving organic matter such as organic fertilizer can provide macro (N, P, K, Ca, Mg, and S) and micro nutrients such as Zn, Cu, Mo, Co, B, Mn, and Fe even in small amounts. Organic matter can also increased soil cation exchange capacity, soil pH, P nutrients and crop yields [8]. One of the organic materials that can be used is compost and organic fertilizer

Organic fertilizers play a role in influencing the physical, chemical, and biological properties of the soil. Organic fertilizers have a chemical role in providing N, P, and K for plants, a biological role in influencing the activities of macroflora and microfauna organisms and a physical role in improving soil structure [9].

In fact, organic manure alone might not meet the plant's requirements due to the relatively low nutrient contents and the slow release of plant nutrients [10]. The integrated use of chemical and organic fertilizers improves plant growth and increases rice yield and quality [11]. High yield that sustainability can be achieved if NPK fertilization is combined with the use of organic matter [12, 13, 14] stated that the response of plants to the application of inorganic fertilizers is strongly influenced by the content of organic matter in the soil.

The application of organic fertilizers is known to increase crop production [15]. On the other hand, inorganic fertilizers in the cultivation of food crops are still very much needed, especially fertilizers containing N, P, and K elements readily available to plants, mostly paddy crops. Fertilization at a dose of 300 kg urea ha⁻¹, 50 kg SP-36 ha⁻¹, and 150 kg KCl ha⁻¹ significantly increased the growth and yield of paddy crops [16, 17].

Nutrients supplied exclusively through chemical fertilizers (CFs) enhance the yield of rice initially, but the yields are not sustainable over time. Imbalanced use of CFs decreases soil fertility and reduces 38% of grain yield in rice [18]. Thus, there has been a growing interest in the use of organic fertilizers as a source of nutrients. Similar to CFs, organic fertilizers such as Poultry Manure (PM) mainly contain nitrogenous compounds, which are readily mineralized to ammonia and nitrate [19]. Cow Manure (CM), an important nutrient source for crop production, is rich in N content and recognized as a substitute for inorganic fertilizer [20]. The present research aimed to clarify the influence of combined organic and inorganic fertilizers on growth, yield, and profite rice farming in paddy field.

2. Material and methods

The field experiment was conducted at paddy fields of Dengkol Village, Singosari Subdistrict, Malang District, East Java Province, Indonesia. It was carried out during the rainy season 2018. Chemical analysis were conducted at Soil Chesmitry Laboratory, East Java Assessment Institute for Agricultural Technology, Malang. The materials used included Rice varieties of Inpari-4, organic fertilizer, Urea and NPK Phonska fertilizer.

The research was designed in Randomized Block Design (RBD), 3 replicates, and 8 treatments. The observed treatments were as follow :

A = without fertilizer,

B = 200 kg Urea ha⁻¹ + 300 kg NPK Phonska ha⁻¹ (Recommended Rates of Inorganic Fertilizer or RRIF),

C = RRIF + 2 tons organic fertilizer ha⁻¹,

D = RRIF + 4 tons organic fertilizer ha⁻¹,

E = RRIF + 6 tons organic fertilizer ha⁻¹,

F = 50% RRIF + 2 tons organic fertilizer ha⁻¹,

G = 50% RRIF + 4 tons organic fertilizer ha⁻¹,

H = 50% RRIF + 6 tons organic fertilizer ha⁻¹,

The research used plot of 4,0 m x 10,0 m, Between plots is limited by bunds with a width of 50 cm and a height of 25 cm, the water intake and output channels are separated to ensure that fertilization treatment between plots does not occur mixed with the flow of

fertilizer solution or seepage of fertilizer solution between plots. The planted rice variety was Inpari 4 with spacing 25 cm x 25 cm and 3-4 sticks per clump per hole.

Table 1. Analysis results of the nutrient contents of organic fertilizer

Number	Test Parameters	Results	Unit	Metode
1.	C-organic	16.76	%	Dry ashing 660°C
2.	C/N ratio	15.38		
3.	by-products (plastic, glass, water)	0.52	%	Sorting and sifting
4.	Heavy metal :			
	Arsen (Ag)	1.81	ppm	Wet oxidation (HNO ₃ + HClO ₄), AAS ⁻ Hydride
	Hydrargyrum (Hg)	< 0.25	ppm	Wet oxidation (HNO ₃ + HClO ₄), AAS ⁻ Hydride Cold
	Plumbum (Pb)	1.69	ppm	Vapour
				Wet oxidation (HNO ₃ + HClO ₄), AAS
	Cadmium (Cd)	< 0.125	ppm	Wet oxidation (HNO ₃ + HClO ₄), AAS ⁻
6.	pH	7.97		Elektrometry, pH meter, (1 : 5)
7.	N total content	1.09	%	Kjeldahl; Titrimetry
8.	P ₂ O ₅ content	1.47	%	Wet oxidation (HNO ₃ + HClO ₄), Molibdovanadat, Spectrometry
9.	K ₂ O content	1.45	%	Wet oxidation (HNO ₃ + HClO ₄), AAS,
10.	Microbial contaminants :			Flamephotometry
	<i>Escherichia coli</i>	Negatif		
11.	<i>Salmonella sp.</i>	Negatif		
12.	Grain size 2 – 5 mm	90.27		Most Probable Number (MPN)
13.	Fe total content	3482.5	ppm	Most Probable Number (MPN)
14.	Fe available content	58,0	ppm	Sifting
15.	Mn content	1338.40	ppm	Morgan Wolf Extraction, AAS
				Morgan Wolf Extraction, AAS
16.	Zn content	95.20	ppm	Wet oxidation (HNO ₃ + HClO ₄), AAS
17.	La content	0.00	ppm	Wet oxidation (HNO ₃ + HClO ₄), AAS
18.	Ce content	0.00	ppm	Wet oxidation (HNO ₃ + HClO ₄), AAS
				Wet oxidation (HNO ₃ + HClO ₄), AAS

Based on Table 1 showed the result of analysis on fertilizer considered it as organic fertilizer because it contains C-organic = 16.76%, N-total = 1.09%, P₂O₅ = 1.47%, K₂O = 1.45%, C/N ratio = 15.38, and pH = 7.97. Quality of the organic fertilizer in accordance with quality requisite [10], the used indicators include C-organic level = minimum 15%, C/N ratio ≤ 25, N + P₂O₅ + K₂O = minimum 2%, and pH = 4 – 9 [21] The test was conducted at Soil Chemistry Laboratory, East Java Assessment Institute for Agricultural Technology. Malang.

Seeds were sown in nursery boxes and transferred to the field at the age of 18 days after sowing. Planting density was 25 cm space between crops and 25 cm between rows. Weeds were controlled twice manually by hand and irrigation was conducted through a basin irrigation system based on weather conditions and plant requirements The application of organic fertilizer was spreaded on the surface at the same time as tillage. Urea and NPK Phonska fertilizer was broadcasted at three stages (50% as a top dress before the maximum

tillering stage, 25% as a top dress at the panicle initiation stage, and 25% at the flowering stage). Weeding, irrigation, and pest control were performed if necessary.

The soil was excavated using a soil drill in accordance with the depth to be studied, namely 0-20 cm at each sampling point. At each sampling location, 5 (points) were taken. Then the soil at the five points was mixed evenly. After that, the composite sample was put into a plastic bag of ± 1 kg to be analyzed in laboratory.

Ten hills were selected to measure growth and yield attributes consisting of plant height, number of tillers per clump, numbers of panicle per clump, 1000 grain weight, empty grain, and grain yield of rice. Plant height was recorded with a common ruler from the surface of the soil to the tip of the plant, and yield and its components were recorded at 14% moisture content by a moisture tester.

Data were analyzed statistically using SAS program over the observed variables using Analysis of Variance (ANOVA) with trust interval of 5% and Duncan's test (DMRT = Duncan Multiple Range Test) at level 5% for the significant different effects of the variables [22].

Effectiveness for organic fertilizer is approached using *Relative Agronomic Effectiveness* (RAE) method [23]. Each treatment is tested against standard fertilizer (in this test is treatment B). RAE is ratio between the increasing yield following the application of fertilizer and the increasing yield after using standard fertilizer, and multiplied by 100. RAE equation is given below :

$$RAE = \frac{\text{Yield of the tested fertilizer} - \text{control}}{\text{Yield of the standard fertilizer} - \text{control}} \times 100\%$$

Financial analysis on farming operation was performed to find out its properness. Farming analysis used the economic analysis calculation with R/C-ratio (Revenue Cost ratio) or ratio between revenue and cost. Analysis tool for R/C-ratio [24] with equation as follows :

$$R/C \text{ ratio} = NPT/BT$$

In which, R/C = Revenue and Cost Ratio

NPT = Total production value (IDR ha⁻¹)

BT = Total cost value (IDR ha⁻¹)

If, R/C > 1 : Feasible to be developed

R/C = 1 : Break even

R/C < 1 : Not feasible to be developed

3. Results and Discussion

3.1. Soil characteristics at study site

In early test, soil samples were taken to find out soil fertility status and the inhibiting factors of growth at location of the test. Results of analysis on several chemical properties of the soils and the criteria are presented in Table 2.

Results of analysis on chemical properties of the soils according to [25] (Table 2) showed that soil texture is clay, Cation Exchange Capacity (CEC) in the soils is high with base cations, such as moderate K can be exchanged, moderate Na can be exchanged, moderate Ca can be exchanged, and high Mg can be exchanged.

Based on the characteristics of the land, the nutrient content of the land was low except for the P nutrient. The increase in the availability of P in the inundated soil was caused, among others, by the reduction of ferric phosphate, the release of P from Ca, Al, and Fe bonds and an increase in the pH of acidic soils [26]. In order for this land to have maximum productivity, nutrients The barrier is added to the soil by the addition of organic matter through the return of straw or manure and organic fertilizers.

The results of soil analysis showed that the pH of the soil was slightly acidic with a pH of 5.7 H₂O, while pH of 4.6 KCl. C-organic content is low, N-total is low, and C/N ratio of 10.75 is moderate, while soil P content is high and K content is moderate. Cation

Exchange Rate: K can be exchanged was low, Na can be exchanged was low, Ca can be exchanged was moderate, Mg can be exchanged was high, Cation Exchange Capacity (CEC) in soil was high. According to [27], the optimum availability for element P was in the neutral pH range of 6.5 – 7.0, while the optimum availability for K was at pH 6.5 – 7.2.

Table 2. Soil analysis results before the research performed at Malang District, rainy season, 2018

No.	Soil Chemical Properties	Results	Unit	Method	Category
1.	pH H ₂ O	6.0	-	(1:5), Electrometry, pH meter	Slightly acid
	pH KCl	5,0	-	(1:5), Electrometry, pH meter	Acid
2.	C-organic	1.72	%	Wakley & Black; Spectrophotometry	Low
3.	N total	0.16	%	Kjeldahl, Titrimetry	Low
4.	C/N ratio	10.75			Moderate
5.	P ₂ O ₅ Bray 1	75.20	ppm	Olsen, Spectrophotometry	High
6.	Cation exchange rate Cations can be exchanged				
	K	0.31	me 100 g ⁻¹	Percolation NH ₄ , Acetat 1 M, pH 7, AAS	Moderate
	Na	0.03	me 100 g ⁻¹	Percolation NH ₄ , Acetat 1 M, pH 7, AAS	Low
	Ca	7.38	me 100 g ⁻¹	Percolation NH ₄ , Acetat 1 M, pH 7, AAS	Moderate
	Mg	2,57	me 100 g ⁻¹	Percolation NH ₄ , Acetat 1 M, pH 7, pH 7 + NaCl 10% Titrimetry	High
7.	Cation Exchange Capacity (CEC)	29.93	cmol c kg ⁻¹		High
8.	Texture				
	Sand	12	%	Hidrometer	
	Dust	41	%	Hidrometer	
	Clay	47	%	Hidrometer	
	Class	clay	-	Triangle Texture USDA	

Optimal availability of P is within the range of neutral pH, 6.5 – 7.0, while optimal availability of K is within the range of pH 6.5 – 7.2. Low pH is not due to Al or Fe activities, but the increase ion H⁺ that derived from organic acids, such as oxalate, fulphate, citrate, and malate as a result of organic material decomposition [28, 29].

Table 3 presents soil pH (H₂O = 6.4 and KCl = 6.0) is slightly acid. According to [14], soil pH ranges between 5 to 7 is fairly well for rice development, N total and C-organic are low (1.00), N total is low, C/N ratio is low (6.67), P and K contents are moderate. Meanwhile [30], reported that soil pH below 6.5 may cause P unavailable because it relates to Fe and Al, which form insoluble compounds.

Low soil pH highly affects nutrients availability as reflected by low nutrients availability, such as N, P, and K. It is due to K⁺ ion is released from soil absorption complex and filled with Al⁺ and H⁺ ions. Such condition is considered acid with sufficient contents of N, P, and K, but low Cation Exchange Capacity (CEC), so that it requires additional nutrients through the application of NPK fertilizer.

Bioslurry fertilizer was useful in improving the quality of agricultural soil by neutralizing acid condition, increased humus content as much as 10-12% and support the

activity of earthworm development and the role of microbial soil on plants. That use of bio-slurry improved the soil physical structure, increased the ability of soil holding water capacity and soil fertility [31, 32].

3.2. Corn Growth

3.2.1. Plant Height.

Results for analysis of variance showed that the application of organic combined with inorganic fertilizers, which are derived from Urea and NPK Phonska, have not significant effects on plant height of rice at 21, and 42 DAP except at 63 DAP. Results of observation on plants at 21, 42, and 63 DAP are presented in Table 3.

Table 3. Effect of organic and inorganic fertilizer application on plant height at 21, 42, and 63 DAP on paddy field, rainy season, 2018, Malang District

Code	Treatments	Plant Height (cm)		
		21 DAP	42 DAP	63 DAP
A	0 kg Urea ha ⁻¹ + 0 kg NPK Phonska ha ⁻¹ + 0 organic fertilizer ha ⁻¹	26.83 a	44.96 a	63.66 a
B	200 kg Urea ha ⁻¹ + 300 kg NPK Phonska ha ⁻¹ (RRIF)	31.10 a	47.70 a	75.24 cd
C	RRIF + 2 tons organic fertilizer ha ⁻¹	31.92 a	47.25 a	75.50 cd
D	RRIF + 4 tons organic fertilizer ha ⁻¹	32.64 a	48.33 a	77.71 de
E	RRIF + 6 tons organic fertilizer ha ⁻¹	34.16 a	50.22 a	80.12 e
F	50% RRIF + 2 tons organic fertilizer ha ⁻¹	30.53 a	46.15 a	71.32 b
G	50% RRIF + 4 tons organic fertilizer ha ⁻¹	31.15 a	46.25 a	73.64 bc
H	50% RRIF + 6 tons organic fertilizer ha ⁻¹	31.89 a	46.70 a	75.65 cd
CV		8.90	5.59	2.12

Note : The numbers followed by the same letter in the same column are not significantly different from the DMRT at the 5%

Results of DMRT test by level 5% at 21 DAP, which were 34.16 cm, respectively, were higher in the E treatment (RRIF + 6 ton organic fertilizer ha⁻¹) compared to others, followed by D, H, G, C, B, F, and A. Results of DMRT test by level 5% at 21 DAP, which were 50.22 cm, respectively, were higher in the E treatment (RRIF + 6 ton organic fertilizer ha⁻¹) compared to others, followed by D, B, C, H, G, F, and A. Results of DMRT test by level 5% at 63 DAP, which were 80.12 cm, respectively, were higher in the E treatment (RRIF + 6 ton organic fertilizer ha⁻¹) compared to others, but not significantly different with D. However, all of these parameters were greater in E treatment (RRIF + 6 ton organic fertilizer ha⁻¹) and were lower in A treatments (without organic and inorganic fertilizers).

At the age of 21, 42, and 63 DAP, plant height growth increased by 8.96%, 5.02%, 20.54% 8.09%, 2.73% respectively with the application of organic fertilizers 6 tons ha⁻¹ comparison to treatment B and increased by 21.46%, 5.01%, and 6.09% compared to treatment A (without organic and inorganic fertilizers). It was presumed that the application of organic fertilizer to increase C-organic soil, which is required by the rice and affected by the available fertilizer application for vegetative growth, especially N, P, and K, which were derived from Urea and NPK Phonska, which is required to promote the plant height.

The highest plants were obtained in the combination treatment of organic fertilizer 5 ton ha⁻¹ + 200 kg kg Urea ha⁻¹ + 300 kg NPK ha⁻¹ + 20 lt POC bio urine ha⁻¹ (T₄) and significantly different from other treatments. When compared to the farmer method = 200 kg Urea ha⁻¹ + 300 kg NPK ha⁻¹ (T₁), it was 4.7% higher. The increased in plant height due to administration and increase in doses of organic and inorganic fertilizers is thought to be

related to the influence of N which stimulates various plant physiological activities, such as in the process of cell division and plant cell elongation. The highest crop was obtained in the combination treatment of organic fertilizer 5 ton ha⁻¹ + 200 kg Urea ha⁻¹ + 300 kg NPK ha⁻¹ + 20 liters of POC biourine ha⁻¹ (T₄). When compared with the farmer method of 200 kg Urea ha⁻¹ + 300 kg NPK ha⁻¹ (farmer's method) (T₁) it was 4.7% higher [33].

Plant height of Manawthukha was superior to that of Genkitsukushi throughout the crop growing period ($P < 0.05$). In both rice varieties, CF₅₀PM₅₀ (50% Chemical fertilizer, 50% Poultry Manure) treatment provided taller plants at all the growth stages. Maximum plant height was attained at harvest (109.76 cm in Manawthukha and 102.49 cm in Genkitsukushi). Plant heights in CF₅₀CM₅₀ (50% Chemical fertilizer, 50% Cow Manure) and CF₅₀CP₅₀ (50% Chemical fertilizer, 50% Compost) treatments were the same as those in CF₁₀₀ in both varieties [34].

The highest height of rice plants was reached by the treatment of NPK fertilizer only (P₁) with the average height of rice plant was 75.9 cm. However, it was not significantly different to the treatment of P₂, P₃, P₄ and P₅. Treatments of P₁, P₂, P₃, and P₄ were significantly different ($p < 0.05$) compared to the control (P₀), however treatment P₅ was not significantly different compared to the control. These indicated that either bio-slurry applied solely or in combination with NPK fertilizer increased the growth of rice plants. This finding proved that bio-slurry applied solely and mixed with NPK fertilizer may replace the role of inorganic fertilizer in affecting the performance of rice. Inorganic fertilizer increased the growth of rice plants due to the nutrient released from inorganic fertilizer directly available to plants. Therefore, the nutrients contained in inorganic fertilizer may be used directly to support plant growth. Through mineralization bio-slurry may release the nutrients into soil and increase nutrients availability, and consequently improves soil fertility, and available nutrients meet the nutrient required by plants [35].

Pellet fertilizer at a dose of 30 tons ha⁻¹ was no significant difference when compared to the plant height in the treatment at a dose of 10 tons ha⁻¹ and a dose of 20 tons ha⁻¹, but all three were significantly higher than the control treatment (no fertilizer). It shows that the application of pellets organic fertilizer at a dose of 10 tons ha⁻¹ had increased swampland paddy growth. The increase in the dosage of organic pellet fertilizers did not show a significant difference in plant height. Optimal plant growth can be achieved if the nutrients needed for plant growth and yield are available in optimum and proportional quantities. The availability of nutrients and balanced amounts will affect plants' metabolic processes to grow and develop [36, 37].

The nutrient supply from organic manure can be excessive or insufficient for rice growth and unsynchronized with crop N demands. Applied PM (poultry manure), CM (cow manure) and CP (bamboo powder compost) based on EMN (estimated mineralizable N (EMN) depending on their total N content [38]. Reduced the amount of CF (chemical fertilizer) to 50% of the recommended rate without decreasing the growth parameters or yields of either rice variety using organic manure (EMN) and CF. Therefore, the integrated 50% EMN with PM, CM or CP and 50% of the recommended CF was effective in terms of growth parameters and yields in Manawthukha and Genkitsukushi, compared with CF₁₀₀ alone. Growth parameters and yields of rice affected by CF, PM, CM and CP Basal CF has traditionally been broadcast or mixed in a shallow soil layer by rice farmers. This approach enhances NH₄-N content in the surface soil layer and flood waters [39]. It is not necessary to maintain a high N concentration in the top soil layer during the early growth stage because the rice root is too small and plant N demand is low [40].

Combined application of different doses of vermicompost and fertilizer had significant effect on plant height of rice. The highest plant height (95.78 cm) was observed from V₃F₂ (vermicompost 4 t ha⁻¹, medium level (100-16-66-12 kg N, P, K, S ha⁻¹) and it was statistically similar with V₃F₃ (vermicompost 4 t ha⁻¹, high level (150-24-99-18 kg N, P, K, S ha⁻¹), V₂F₃ (vermicompost 2 t ha⁻¹, high level (150-24-99-18 kg N, P, K, S ha⁻¹), V₀F₃ (vermicompost 0 t ha⁻¹, high level (150-24-99-18 kg N, P, K, S ha⁻¹), V₂F₂

(vermicompost 2 t ha⁻¹, medium level (100-16-66-12 kg N, P, K, S ha⁻¹), V₂F₁ (vermicompost 2 t ha⁻¹, low level (50- 8-33-6 kg N, P, K, S ha⁻¹), V₁F₃ (vermicompost 1 t ha⁻¹, high level (150-24-99-18 kg N, P, K, S ha⁻¹), and V₃F₁ (vermicompost 4 t ha⁻¹, low level (50- 8-33-6 kg N, P, K, S ha⁻¹), whereas, the lowest (86.04 cm) was found from V₀F₀. The variation in plant height due to nutrient sources was considered to be the variation in the availability of major nutrients. Chemical fertilizer offers nutrients which are readily soluble in soil solution and thereby instantaneously available to plants. Nutrient availability from organic sources is due to microbial action and improved physical condition of soil [41].

3.2.2. Number of Tillers per Clump

Results analysis of variance showed that the application of organic fertilizer combined with inorganic fertilizers, which are derived from Urea and NPK Phonska, have not significant effects on number of tillers per clump of rice at 21, 42, and 63 DAP. Results of observation on plants at 21, 42, and 63 DAP are presented in Table 4.

Table 4. Effect of organic and inorganic fertilizer application on number of tillers per clump at 21, 42, and 63 DAP on paddy field, rainy season, 2018, Malang District

Code	Treatments	Number of Tillers per Clump (stems)		
		21 DAP	42 DAP	63 DAP
A	0 kg Urea ha ⁻¹ + 0 kg NPK Phonska ha ⁻¹ + 0 organic fertilizer ha ⁻¹	8.43 a	9,58 a	13.35 a
B	200 kg Urea ha ⁻¹ + 300 kg NPK Phonska ha ⁻¹ (RRIF)	12.10 b	13.92 a	19.40 b
C	RRIF + 2 tons organic fertilizer ha ⁻¹	12.35 b	14.53 a	20.12 b
D	RRIF + 4 tons organic fertilizer ha ⁻¹	12.78 b	14.77 a	21.14 b
E	RRIF + 6 tons organic fertilizer ha ⁻¹	12.92 b	16.64 a	21.68 b
F	50% RRIF + 2 tons organic fertilizer ha ⁻¹	12.25 b	12.30 a	18.92 b
G	50% RRIF + 4 tons organic fertilizer ha ⁻¹	12.32 b	13.12 a	19.32 b
H	50% RRIF + 6 tons organic fertilizer ha ⁻¹	12.33 b	13.5 a	20.33 b
CV (%)		10.32	20.70	11.31

Note : The numbers followed by the same letter in the same column are not significantly different from the DMRT at the 5%

Results of DMRT test by level 5% at 21 DAP, the application of 200 kg Urea ha⁻¹ + 300 kg NPK Phonska ha⁻¹ + 6 ton organic fertilizer ha⁻¹ resulted the highest number of tillers per clump, but not significantly different with other treatments except treatment A. Results of DMRT test by level 5% at 42 DAP, fertilizer application of E = RRIF + 6 tons organic fertilizer ha⁻¹ showed the highest growth, but not significantly different with other treatments. Results of DMRT test by level 5% at 63 DAP, the application of RRIF + 6 tons organic fertilizer ha⁻¹ resulted the highest number of tillers per clump, but not significantly different with other treatments excepted treatment A.

Results for analysis of variance showed that the application of fertilizer RRIF + 6 tons organic fertilizer ha⁻¹ at 21, 42, and 63 DAP have resulted number of tillers per clump 12.92, 16.64, and 21.68 stems per clump. At 63 DAP, the treatment RRIF + 6 tons organic fertilizer ha⁻¹ showed it increased 12.30% in comparison with fertilizer application with the recommended dosage of inorganic fertilizer (treatment B).

Harvest Index (HI) ranged from 0.33 to 0.49 in Manawthukha and from 0.52 to 0.61 in Genkitsukus. Manawthukha produced more panicles per hill than Genkitsukushi (P

0.05). In the integrated treatments, CF₅₀PM₅₀ plots produced the highest value. A similar value (16.08) was recorded by CF₁₀₀ treatment. Plants in CF₅₀CM₅₀, CF₅₀CP₅₀ and CF₅₀ treatments produced 14.08, 13.83 and 13.50 panicles per hill, respectively [34].

The treatment of 5 t of organic fertilizer ha⁻¹ + 200 kg of urea ha⁻¹ + 300 kg of NPK ha⁻¹ + 20 lt of POC bio urine ha⁻¹ (T₄) gave 29.5% more tillers than the farmer method (T₁) and significantly different in other treatments. The application of NPK fertilizer combined with organic fertilizer (straw, cow manure and petroganik), can increase the number of rice tillers by about 18-37% [42, 33].

The number of productive tillers is one component that has a large role in the production of rice plants. Nutrient supply that stimulates the growth of dormant shoots, which has a positive effect on root growth. Vigor roots will carry out their functions well in absorbing water and nutrients so that they can stimulate the growth of the upper part of the plant such as plant height and the number of productive tillers for the better [43].

The number of tillers hill⁻¹ was not significantly affected by the different inorganic fertilizer treatments in either season. There was no statistically significant difference in the number of tillers generated using 100% NPK = 150 kg N ha⁻¹, 70 kg P₂O₅ ha⁻¹, and 120 kg K₂O ha⁻¹ (I₁₀₀) compared with 50% NPK (I₅₀) inorganic fertilizer. However, a larger number of tillers were present in rice plants grown using I₁₀₀ compared with 0% NPK (I₀) fertilizer. The maximum tiller number was produced using 75% NPK with 5 tons poultry manure ha⁻¹ (I₇₅O_p) in the dry season (19.22 hill⁻¹) and I₁₀₀O_p in the wet season (17.00 hill⁻¹). The cow manure (O_c) and vermicompost (O_v) treatments did not produce the maximum number of tillers with any inorganic fertilizer. The no organic manure (O₀) plots were also unable to produce the maximum number of tillers with any inorganic fertilizer. The number of tillers hill⁻¹ produced using I₀O₀ was obviously low since no fertilizer was applied. The results from both seasons were similar [34].

The highest average number of tillers in organic fertilizer treatment was at K₀ = 0 ton ha⁻¹ (19.40 stems) and the lowest at K₂ = 10 ton ha⁻¹ (18.20 stems) or the maximum number of tillers was 65% higher in control compared to K₂. The average value of productive tillers in organic fertilizer treatment was highest at K₀ (18.60) and the lowest at K₂ (16.73) or the number of productive tillers was 13.32% higher in control than in K₂. While the maximum number of tillers and productive tillers due to the highest dose of inorganic fertilizer treatment was at P₄ = 250 kg Urea ha⁻¹ + 75 kg SP-36 ha⁻¹ + 75 kg KCl ha⁻¹ each value (22.78 stems), (21.67 stems), and the lowest was at P₀ (15.67 stems), (14.11 stems) or the maximum number of tillers and productive tillers was 45.73% and 53.57% higher in P₄ than control [44]. The number of productive tillers is an important yield component in rice plants [45].

3.3. Yield Component (Number of Panicles per Clump, 1000 Grain Weight, Empty Grain (% by weight), Grain Yield of Rice)

Results analysis of variance showed that the application of organic fertilizer combined with inorganic fertilizers, which are derived from Urea and NPK Phonska, have significant effects on number of panicles per clump and yield of dry grain, but not significant effects different on 1000 grain weight and empty grain (% by weight). The results of observations on the number of panicles per clump, 1000 grain weight, empty grain (% by weight), and grain yield of rice are presented in Table 5.

The highest numbers of panicle per clumps was obtained by the application of fertilizer (E = RRIF + 6 tons organic fertilizer ha⁻¹) 18.85 even though it did not show significant difference with fertilizer application of D, E, G, and H or increased 13.41% in comparison with the recommended rates of inorganic fertilizers (treatment B) 16.62.

A steady supply of nutrients at the panicle initiation and grain filling stages ensures that the maximum number of spikelets panicle⁻¹ can be attained using poultry manure (O_p) treatment. Treatment using cow manure (O_c) and vermicompost (O_v) also results in a high number of spikelets panicle⁻¹ [46] also reported that spikelets panicle⁻¹ increased significantly when organic manures and chemical fertilizers were combined. The maximum filled grain percentage was produced by O_p treatment in both seasons. This is consistent with work by [47], which demonstrated that O_p treatment produced better

physical grain characteristics. The combined application of manures and fertilizers also significantly increases the number of filled grains panicle⁻¹ [48].

Table 5. Effect of organic and inorganic fertilizer application on Number of panicles per clump, 1000 grain weight, empty grain (% by weight), grain yield of rice on paddy field, rainy season, 2018, Malang District

Code	Treatments	Numbers of panicle per clumps	1000 grain weight (gram)	Empty grain (% by weight)	Grain yield of rice (ton ha ⁻¹)
A	0 kg Urea ha ⁻¹ + 0 kg NPK Phonska ha ⁻¹ + 0 organic fertilizer ha ⁻¹	11.53 a	21.46 a	13.53 b	4,12 a
B	200 kg Urea ha ⁻¹ + 300 kg NPK Phonska ha ⁻¹ (RRIF)	16.62 b	26.73 b	7.80 a	6.47 bc
C	RRIF + 2 tons organic fertilizer ha ⁻¹	16.88 b	26.44 b	8.12 a	6.68 c
D	RRIF + 4 tons organic fertilizer ha ⁻¹	18.12 bc	26.88 b	7.97 a	7,42 de
E	RRIF + 6 tons organic fertilizer ha ⁻¹	18.85 c	27,52 b	7.26 a	7,65 e
F	50% RRIF + 2 tons organic fertilizer ha ⁻¹	17.15 bc	26,87 b	8,25 a	6.26 b
G	50% RRIF + 4 tons organic fertilizer ha ⁻¹	17.34 bc	26.79 b	8.10 a	6.72 c
H	50% RRIF + 6 tons organic fertilizer ha ⁻¹	17.72 bc	27.12 b	7.56 a	7,23 d
CV (%)		5.35	3.03	6.69	3.36

Note : The numbers followed by the same letter in the same column are not significantly different from the DMRT at the 5%

Thousand grain weight was unaffected by organic and inorganic fertilizer treatment types in either season. The thousand grain weight of rice was not significantly influenced by inorganic fertilizer levels because this depends mainly on genetic factors that are unique to each variety. Combining organic manures and inorganic fertilizers also increased panicle length compared with no inorganic fertilizer and no organic manure (I₀O₀) treatment [49, 50]. That applying organic manures together with chemical fertilizers increased panicle length. Supplying organic and inorganic fertilizers together increases the quantities of a variety of nutrients simultaneously and can reduce the amount of N lost by converting inorganic into organic N [51].

The highest numbers of panicle per clumps was obtained by the application of fertilizer (E = RRIF + 6 tons organic fertilizer ha⁻¹) 18.85 even though it did not show significant difference with fertilizer application of D, E, G, and H or increased 13.41% in comparison with the recommended rates of inorganic fertilizers (treatment B) 16.62.

The highest weight of 1000 grain weight was obtained by the application of fertilizer E = RRIF + 6 tons organic fertilizer ha⁻¹, 27.52 gram higher than other treatments even it is statistically non significant with other treatment except treatment A or increase 2.97% in comparison with the Recommended Rates of Inorganic Fertilizers (treatment B) 26.73 gram.

Results on analysis of variance toward weight of 1000 grain showed non significant effect of the application of organic and inorganic fertilizer Urea + NPK Phonska. Average weight of 1000 grain weight of rice ranged 26.44 – 27.52 gram. Data in Table 5 showed that the application of each dosage organic and inorganic fertilizer Urea + NPK Phonska not has changed weight of 1000 grain of rice. The increased dosage organic fertilizer into 6 tons ha⁻¹ has increased weight of 1000 grain of rice for about 2.96% in comparison with without organic fertilizer application (RRIF).

1000-grain weight was unaffected by the integrated organic and inorganic fertilizer treatments but was affected by the rice variety. Genkitsukushi produced a higher 1000-grain weight (27.25 g) than Manawthukha (19.57 g). The panicle of Manawthukha was significantly longer than that of Genkitsukushi ($P < 0.05$). Panicle length was not significantly affected by the integrated treatments. Nonetheless, CF50PM50 treatment produced the longest panicles (23.57 cm) [34].

Dry weights of 1000 grain indicate size and filled out seeds, as well as an indicator of seed quality. The higher dry weight of 1000 seeds, the seeds are more qualified. Tillers formation and seed filling are description of the photosynthate functions, which are translocated for the development of reproductive organs. Moreover, the increase of dry weight of seeds relates to the amount of photosynthates, which are translocated to the seeds, the increase of nutrients status in the soils and the more favorable rooting system to absorb nutrients from the soils. High photosynthates translocation to reproductive organs may promote tillers formation and seed filling, however, the seeds are filled out and have bigger size that depend on development of the photosynthetic organs and the environmental supports. The weight of 1,000 grains is more dominated by plant genetic factors [52].

Different levels of vermicompost had significant effect on 1000 grain weight of rice. The highest 1000 grain weight (22.88 g) was calculated from 4 t ha⁻¹ vermicompost application whereas, the lowest (21.89 g) was found from control treatment. 1000 grain weight is mostly mediated by genetic potential but in this case it declines significantly with decreased application of vermicompost as well as with control treatment due to severe deficiency of essential nutrients and hence the plants failed to produce a bold grain. 1000 grain weight of rice significantly influenced by different levels of NPKS fertilizers. The highest 1000 grain weight (23.23 g) was calculated from 150-24-99-18 kg N, P, K, S ha⁻¹ fertilizer which was statistically similar with 100-16-66-12 kg N, P, K, S ha⁻¹ and 50-8-33-6 kg N, P, K, S ha⁻¹ fertilizer whereas, the lowest (21.03 g) was found from F₀ treatment. Interaction effect of different doses of vermicompost and NPKS fertilizer had significant effect on 1000 grain weight of rice. The highest 1000 grain weight (23.83 g) was obtained from 0 ton ha⁻¹ vermicompost V₃F₂ which was statistically similar with 0 ton ha⁻¹ vermicompost and 150-24-99-18 kg N, P, K, S ha⁻¹ (V₀F₃), 4 ton ha⁻¹ vermicompost and 150-24-99-18 kg N, P, K, S ha⁻¹ (V₃F₃), 1 ton ha⁻¹ vermicompost and 150-24-99-18 kg N, P, K, S ha⁻¹ (V₁F₃), 4 ton ha⁻¹ vermicompost and 50-8-33-6 kg N, P, K, S ha⁻¹ (V₃F₁), 1 ton ha⁻¹ vermicompost and 100-16-66-12 kg N, P, K, S ha⁻¹ (V₁F₂), 2 ton ha⁻¹ vermicompost and 50-8-33-6 kg N, P, K, S ha⁻¹ (V₂F₁), 2 ton ha⁻¹ vermicompost and 150-24-99-18 kg N, P, K, S (V₂F₃), 2 ton ha⁻¹ vermicompost and 100-16-66-12 kg N, P, K, S ha⁻¹ (V₂F₂), 1 ton ha⁻¹ vermicompost and 50-8-33-6 kg N, P, K, S ha⁻¹ (V₁F₁) and 2 ton ha⁻¹ vermicompost and 0-0-0-0 kg N, P, K, S ha⁻¹ (V₂F₀) whereas, the lowest (19.70 g) was recorded from V₀F₀ and it was statistically at par with V₁F₀ and V₃F₀ treatment [41]. 1000 grain weight was increased by the application of chemical fertilizer along with organic manure. The increase in grain yield components can be due to the fact that available water enhanced nutrient availability which improved nitrogen and other macro- and microelements absorption as well as enhancing the production and translocation of the dry matter content from source to sink [53, 54].

The highest empty grain was obtained by the application of fertilizer A = 0 kg urea ha⁻¹ + 0 kg NPK Phonska ha⁻¹ + 0 organic fertilizer ha⁻¹ (without fertilizer) 13.53% higher than other treatments even it is statistically significant with other treatment or increase 73.46% in comparison with the Recommended Rates of Inorganic Fertilizers (treatment B) 26.73 gram. The lowest empty grain was resulted by treatment E = 7.26%

The empty grain produced by the rice variety showed that the Inpari 9 varietal treatment had the highest percentage of empty grain at 27.94% and the lowest was the Inpari 4 variety at 10.31%. The empty grain in rice was largely determined by the ability of the rice plant to fill. seeds depend on the process of translocation of photosynthate to seeds [55]. According to [56], during the seed filling process, the grain in the panicle was

unfilled, partially filled, and fully filled. The more the number of filled grains of the total grain in the panicle, the higher the percentage of filled grain and the lower the percentage of empty grain.

Analysis of variance on the percentage of empty grain showed that T_1 treatment (inorganic fertilization, namely 200 kg urea + 300 kg NPK ha^{-1} (farmer method)) gave the lowest percentage and was significantly different from T_2 treatment (5 t organic fertilizer ha^{-1} + 20 liters liquid organic fertilizer (POC) bio urine ha^{-1}) but not different from T_3 and T_4 treatments. This is influenced by the nutrient content of N, P and K in inorganic fertilizers. The metabolic process of plants is strongly influenced by the availability of nutrients, especially macronutrients in sufficient and balanced quantities. The results of the study showed that there was a relationship between the number of grains per panicle and the percentage of empty grain on rice production in paddy fields [33]. New types of rice with high yield potential generally must have good properties, two of which are the number of grain per panicle 150-250 grains and the percentage of rice grain is 85-95% (percentage of empty grain is 5-15%) [57]

Results for analysis of variance showed that dose combination between organic and inorganic fertilizer have significant effect on grain yield of harvest. Grain yield of harvest showed that treatment combination between RRIF + 6 tons organic fertilizer ha^{-1} (treatment E) 7.65 ton ha^{-1} produced higher yield of grain, even though it did not show significant difference with fertilizer application of D or increased 18.24% in comparison with the recommended rates of inorganic fertilizers (treatment B) 6,47 ton ha^{-1} .

The combined application of manure with synthetic fertilizer significantly increased rice growth, yield, and yield components of rice in the present experiment. Compared with control, more productive tillers, longer panicles, and maximum filled grain percentage and grain yield were noted in coupled organic and mineral fertilizer treatment in this study. The improvements in growth and yield components of rice were mainly due to the improved soil fertility under combined treatment in this study, which ultimately improved root growth, nutrient uptake, and leaf photosynthetic capacity by providing sufficient macro- and micronutrients from manure and chemical fertilizer throughout the growth period. Our results are also in line with those of [58], who pointed out that the use of manure integrated with chemical fertilizer increased the growth and yield of rice significantly compared to the sole use of chemical fertilizer.

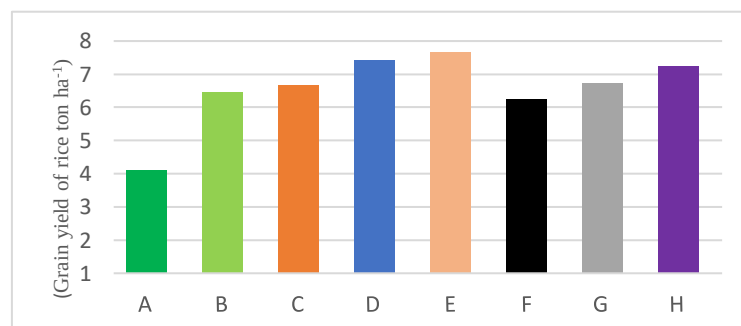


Figure 1. Graphic for grain yield of rice

The maximum grain yield of rice (7.16 ton ha^{-1}) was found from 150-24-99-18 kg ha^{-1} NPKS fertilizer and the lowest (5.14 ton ha^{-1}) was observed from F_0 treatment where no fertilizer was applied found significant increase in rice grain yield due to application of NPK fertilizer. Combined application of different doses of vermicompost and NPKS fertilizer had significant effect on grain yield of rice. The highest grain yield (7.89 ton ha^{-1}) was observed from V_3F_2 (vermicompost 4 ton ha^{-1} , medium level (100-16-66-12 kg

N, P, K, S ha^{-1}) and the lowest (4.41 ton ha^{-1}) was observed from V_0F_0 and it was statistically similar with V_0F_1 treatment. The yield advantages due to integration of organic sources and inorganic fertilizers over chemical fertilizers alone might be due to the availability of nutrients for a shorter period as mineralization of nitrogen is more rapid and in turn the losses of inorganic nitrogen due to volatilization, denitrification and leaching etc., would be more [48, 59, 60] also claimed increased yields of rice with the use of organic manures alone or in combination with chemical fertilizers.

Rice growth, yield, and yield components were significantly affected by joint organic and inorganic N treatments and season, but the interaction of treatments and seasons was not non significant. Relative to T_2 (100% Chemical Fertilizer), T_6 (30% Poultry Manure + 70% Chemical Fertilizer), increased days to maturity, panicle number, panicle length, and grain yield by 5.5% and 7.2%, 14% and 17%, 16% and 19%, 11% and 16% in the early and late seasons, respectively. However, treatment T_6 was statistically ($p < 0.05$) comparable to T_4 (30% Cattle Manure + 70% Chemical Fertilizer). Further, T_3 (60% Cattle Manure + 40% Chemical Fertilizer) and T_5 (60% Poultry Manure + 40% Chemical Fertilizer) also had improved yield and yield components. The lowest yield and yield attributes were noted in T_1 (No chemical Fertilizer) during both seasons [33].

Integrated application of poultry manure (PM), cow manure (CM), compost (CP) (based on estimated mineralizable nitrogen level,) and chemical fertilizer (CFs) was an effective approach to enhance growth, yield and yield components of Manawthukha (indica) and Genkitsukushi (japonica). CF_{50} (42.5 kg hm^{-2}) + PM_{50} (42.5 kg hm^{-2}) treatment showed the best performance in terms of growth parameters and yields of both rice varieties. CM_{50} (42.5 kg hm^{-2}) may be useful as an effective fertilizer when integrated with CF_{50} (42.5 kg hm^{-2}) where PM is limited. Furthermore, CP_{50} (42.5 kg hm^{-2}), which was made from bamboo powder, also showed great potential as a substitute for 50% of CF in Japanese rice cultivation [34].

The maximum grain yield was produced using I_{100} treatments in both seasons. However, combining organic and inorganic fertilizers resulted in the $I_{50} O_p$ (poultry manure) treatment producing a similar yield to that produced by I_{100} treatments. The $I_{50} O_c$ (cow manure) and $I_{50} O_v$ (vermicompost) treatments also produced high yields. Our analysis demonstrated that O_p had a higher nutrient content than either O_c or O_v [61] found that grain yield was significantly increased by combining organic manures and chemical fertilizers. However, the application of organic manures alone did not significantly enhance the yield of hybrid rice in either season [62] also found that combining manure with chemical fertilizer treatments led to significantly higher yields and yield parameters than using chemical fertilizers alone. Therefore, it is clear that the combined application of organic manures and inorganic fertilizers is highly beneficial for sustainability in crop production [34].

3.4. Relative Agronomic Effectiveness (RAE) Value

Relative Agronomic Effectiveness (RAE) is the level of effectiveness of a fertilizer application compared to standard fertilizer. Effectiveness of the fertilizers was showed by the Relative Agronomic Effectiveness (RAE) toward standard fertilizer as recommended. In this experiment, the standard treatment used treatment B, that was $200 \text{ kg Urea ha}^{-1}$ + $300 \text{ kg NPK Phonska ha}^{-1}$ (RRIF). Grain yield of rice on the treatment was used as standard of RAE 100%. Results of RAE analysis in relation to the effect of combine organic and inorganic fertilizer application on growth and yield of corn are presented in Table 6.

The calculation results of RAE showed that $C = \text{RRIF} + 2 \text{ tons organic fertilizer ha}^{-1}$, $D = \text{RRIF} + 4 \text{ tons organic fertilizer ha}^{-1}$, $E = \text{RRIF} + 6 \text{ tons organic fertilizer ha}^{-1}$, $G = 50\% \text{ RRIF} + 4 \text{ tons organic fertilizer ha}^{-1}$, and $H = 50\% \text{ RRIF} + 6 \text{ tons organic fertilizer ha}^{-1}$ have Relative Agronomic Effectiveness (RAE) values are more than 100%, namely 108.94%, 140.43%, 150.21%, 17.02%, and 132.34% respectively. It was showed by Relative Agronomic Effectiveness (RAE) value more than 100%.

Table 6. Relative Agronomic Effectiveness (RAE) Values of fertilizer application of grain yield of rice

Code	Treatments	Grain yield of rice (ton ha ⁻¹)	Relative Agronomic Effectiveness (RAE) (%)
A	0 kg Urea ha ⁻¹ + 0 kg NPK Phonska ha ⁻¹ + 0 organic fertilizer ha ⁻¹	4.12	-
B	200 kg Urea ha ⁻¹ + 300 kg NPK Phonska ha ⁻¹ (RRIF)	6.47	100
C	RRIF + 2 tons organic fertilizer ha ⁻¹	6.68	108.94
D	RRIF + 4 tons organic fertilizer ha ⁻¹	7.42	140.43
E	RRIF + 6 tons organic fertilizer ha ⁻¹	7.65	150.21
F	50% RRIF + 2 tons organic fertilizer ha ⁻¹	6.26	91.06
G	50 % RRIF + 4 tons organic fertilizer ha ⁻¹	6.87	117.02
H	50% RRIF + 6 tons organic fertilizer ha ⁻¹	7.23	132.34

Based on the calculation of RAE (Relative Agronomic Effectiveness), Organonitrofos single fertilizer or a combination of Organonitrofos fertilizer with inorganic fertilizers agronomically is very good for cucumber plants where the RAE value is greater than 100% (Table 6). RAE in treatment C (75 kg urea ha⁻¹, 150 kg SP-36 ha⁻¹, 75 kg KCl ha⁻¹, 1,000 kg Organonitrophos ha⁻¹) was effective on total biomass because it had an RAE value greater than 100% [63]

The relative yield efficiency among different treatments was significantly influenced compared to the untreated control since all treatment has mean values greater 100 excepted F treatment. The RRIF + 6 tons organic fertilizer ha⁻¹ treatment combination (7.65 ton ha⁻¹) was the most superior in terms.). Relative yield efficiency tended to be higher with combination organic and NPK fertilizer application than with only NPK application. The higher yield obtained in NPK amended plots could be attributed to the quick release of nutrients from NPK fertilizer to the soil and uptake by the crops. Improved relative yield efficiency obtained in organic fertilizer amended plots might be due to its cumulative effect of nutrients released by the effluent to the soil. This observation implies the integration of organic fertilizer and NPK fertilizer which provides additional benefits than sole use of organic fertilizer or NPK.

3.5. Analysis on Corn Farming per Hectare in Malang District, Rainy Season, 2018

Profit rate and efficient farming are indicator of success in farming or properness of the farming technology that being managed. In order to determine the profitable dosage fertilizer, input – output analysis was conducted by an assumption that the calculated production cost is cost for providing production means and fertilizer application and harvest cost, whereas miscellaneous costs are assumed equal for all treatments. Financial analysis of rice farming is presented in Table 7.

Selling price of rice is IDR 4.200 kg⁻¹. In this analysis, change or additional cost are calculated as a result of different fertilizer application, farming cost, and output value due to different fertilizer application. Net income (profit) is calculated by reducing the sale value grain yield of rice and fertilizer cost, as well as harvest cost, and other farming costs (labor costs and cost of production facilities), so that profit of the fertilizer application can be calculated.

Table 7. Financial analysis on farming by the fertilizer application on yield of rice over the area one (1,0) Hectare, Rainy Season, 2018, Malang District, (x IDR.000)

Treatments	Grain Yield of Rice (ton ha ⁻¹)	Cost (IDR)		Gained Gross Income (IDR)	Net Income (Profite) (IDR)	R/C ratio	B/C ratio
		Total Means of Production	Total Labor				
A	4.12	1,170	7,861	17,304	8,273	1.92	2.09
B	6,47	2,220	9,241	27,174	15,713	2,37	1.73
C	6.68	3,220	9,304	28,056	15,842	2.24	1.81
D	7.42	4,220	9,526	31,164	17,418	2.27	1.79
E	7.65	5,220	9,595	32,130	17,313	2.17	1.86
F	6.26	2,695	9,178	26,292	14,419	2.21	1.82
G	6.82	3,695	9,346	28,644	15.603	2.20	1.88
H	7.23	4,695	9,469	30,366	16,202	2.14	1.87

Notes : Price : Urea = IDR 1,800 kg⁻¹; NPK = IDR 2,300 kg⁻¹; organic fertilizer = Rp. 500 kg⁻¹; Selling grain yield of rice is IDR 4.200 kg⁻¹ in Malang District in 2018. It is assumed that the production cost is equal except fertilizer and harvest costs; Net income is total sale value minus fertilizer cost, labor costs, production facility costs, and harvest cost (IDR 300 kg⁻¹)

Results of financial analysis grain yield of rice farming in Malang District over fertilizer treatment of E = (RRIF + 6 tons organic fertilizer ha⁻¹) produced the highest grain yield of rice is 7.65 ton ha⁻¹, the highest gained gross income is IDR 32.130.000,-, and the highest net income (profit) is IDR 17,313,000,- by R/C-ratio 2.17. The treatment B = RRIF (200 kg Urea ha⁻¹ + 300 kg NPK Phonska ha⁻¹) produced grain yield of rice is 6,47 ton ha⁻¹, gained gross income is IDR 27,174,000,-, and net income (profit) is IDR 15,713,000,- by R/C-ratio 2.37. The treatment D = (RRIF + 4 tons organic fertilizer ha⁻¹) produced grain yield of rice is 7.42 ton ha⁻¹, gained gross income is IDR 31,164,000,-, and net income (profit) is IDR 17,418,000,- by R/C-ratio 2.27. The lowest fertilizer application is inorganic fertilizer A = (without fertilizer) produced grain yield of rice is 4.12 ton ha⁻¹, gained gross income is IDR 17,304,000,-, and net income (profit) is IDR 8,273,000,- by R/C-ratio 1.92. Whether high or low the gross income gained by the farmers, it depends on the amount of the yield (grain yield of rice) multiplied by price of grain yield of rice per kg and minus production cost. The application of fertilizer 200 kg Urea ha⁻¹ + 300 kg NPK Phonska ha⁻¹ (RRIF) + 6 tons organic fertilizer ha⁻¹ is considered profitable because R/C ratio > 1, and B/C ratio >

The amount of gross income depends on amount of the yield (grain yield of rice) multiplied grain yield of rice price per kg minus the production costs (labor costs and cost of production facilities). In general, the technology of fertilizer application using organic fertilizer is prospecting and should be developed. It can be seen from R/C ratio, which is higher than 1 (>1). It showed that the fertilizer application technology, which is introduced to the farmers, is economically worth it and good enough. R/C ratio or B/C ratio is profitable if R/C ratio or B/C ratio is higher than one. R/C ratio or B/C ratio > 1 means that the business has run efficiently [24]. It can be said that from farming operation side, technology that applying organic fertilizer to be developed.

The profit and cost aspect in farming operation is important to be considered, whereas the rice farmers usually have limited cost and low productivity. It is expected that each farming technology can be adopted by the farmer. Therefore, in order to be easily adopted by the farmers, such technology should be easily applicable and profitable [64].

Conclusion

The results showed that the application of RRIF + 6 tons organic fertilizer ha⁻¹ in Malang District obtained better growth components (plant height, number of tillers per clumb) and yield components (number panicle per clumbs, 1000 grain weight, empty grain, grain yield of rice) in comparison with other treatments.

The results showed that the application of RRIF + 6 tons organic fertilizer ha⁻¹ obtained the highest grain yield of rice 7.65 ton ha⁻¹ or increased of 18.24% from the RRIF (6.47 ton ha⁻¹), obtained the highest net income IDR 17,313,000,- or increased of 10,20% from the RRIF (net income IDR 15,713,000,-), R/C ratio 2.17, and B/C ratio 1.86.

The application of 6 tons organic fertilizer ha⁻¹ on rice gained R/C ratio > 1, so that it is technically deserved to be developed and gained B/C ratio > 1, so that it is economically profitable. The treatment F = (RRIF + 6 tons organic fertilizer ha⁻¹), showed the effectiveness of 150.21% by Relative Agronomic Effectiveness (RAE) > 100%.

REFERENCES

- [1] Ohajianya D O and Onyenweaku C E 2002 Farm size and relative efficiency in rice production in Ebonyi State, Nigeria. *Modeling Simulation Coni*, D, 23, 1-16
- [2] Peng S B, and Yang J C 2003 Current status of the research on high yielding and high efficiency in resource use and improving grain quality in rice. *Chin J Rice Sci*, **17** 275–280
- [3] Krupnik T J, Six J, Ladha J K, Paine M J, and Kessel C V 2004 An assessment of fertilizer nitrogen recovery efficiency by grain crops. *In*: Mosier A R. *Agriculture and the Nitrogen Cycle : Assessing the Impacts of Fertilizer Use on Food Production and the Environment*. Paris, France : Scientific Committee on Problems of the Environment
- [4] Cao Y S, Tian Y H, Yin B, and Zhu Z L 2013 Assessment of ammonia volatilization from paddy fields under crop management practices aimed to increase grain yield and N efficiency *Field Crops Res* **147** 23–31.
- [5] Central Statistics Agency 2018 National rice production. Jakarta
- [6] Yuniarti, Solihin E, Putri A T A 2020 Application of organic and N, P, K fertilizer to pH, P-available, P absorption, and black rice yield (*Oryza sativa* L.) in inceptisol. *Jurnal Kultivasi* **19** 1040-1046
- [7] Khanafi A, Yafizham and Widjajanto, D W 2018. The effectiveness of Bio-Slurry and inorganic fertilizer combination on the performance of rice (*Oryza sativa* L.) *Journal of Applied Chemical Science* **5** 418-423
- [8] Pane M A, Damanik M M B, and Sitorus B 2014 Provision of organic matter compost of straw and rice husk ash in improving the chemical properties of ultisol soil and the growth of corn plants. *Agroecotechnology Online Journal* **2** 1426-1432
- [9] Jenira H, Sumarjan and Armiani S 2016 Effect of combination of organic fertilizer and inorganic impact on the production of peanut (*Arachis hypogae* L.) local variety bima in an effort to make brochures for the community *Scientific Journal of Biology* **5** 1–12
- [10] Miah M M U. 1994. Prospects and problems of organic farming in Bangladesh. Paper presented at the Workshop on Integrated Nutrient Management for Sustainable Agriculture held at SRDI, Dhaka 26–28
- [11] Masarirambi M T, Mandisodza F C, Mashingaidze A B, Bhebhe 2012 Influence of plant population and seed tuber size on growth and yield components of potato (*Solanum tuberosum*) *Int J Agr Biol* **14** 545–549
- [12] Makinde E A, Agboola A A and Oluwatoyinbo F I 2001 The effect of organic and inorganic fertilizers on the growth and yield of maize in a maize/melon intercrop *Moor Journal of Agricultural Research* **2** 15-20

- [13] Belay A, Classens A S, Wehner F C and De Beer J M 2001 Influence of residual manure on selected nutrient elements and microbial composition of soil under longterm crop rotation. *South Africa J Plant and Soil* **18** 1-6
- [14] Bayu W, Rethman N F G, Hammes P S and Alemu G 2006 Effects of farmyard manure and inorganic fertilizers on sorghum growth, yield and nitrogen use in a semi arid area of Ethiopia *J Plant Nutrition* **29** 391-407
- [15] Angelova V R, Akova V I, Artinova N S and Ivanov K I 2013 The effect of organic characteristics on soil chemical characteristics *Bulgarian Journal of Agricultural Science* **19** 958-971
- [16] Rois A, Syakur A, Basri Z 2017 Adaptation test of Inpara-3 superior rice in Lebak swamp land using various adaptive fertilizer packages adaptif *Journal Agroland* **24** 237-241.
- [17] Djafar Z R 2013 Agronomic activities to increase the potential of lowland land as a food source *Sub Optimal Land Journal* **2** : 58-67
- [18] Singh G R, Chaure N K, Parihar S S 2001 Organic farming for sustainable agriculture *Ind Farming* **52** 12-17
- [19] Eghball B, Wienhold B J, Gilley J E, Eigenberg R A 2002 Mineralization of manure nutrients *J Soil Water Conserv* **57** : 470–473
- [20] Sharma A R, Mitra B N 1991 Direct and residual effect of organic material and phosphorous fertilizers in rice (*Oryza sativa* L.) based cropping system *Ind J Agron* **36** 299-303
- [21] Regulation of Minister of Agriculture Number 261/Regulation of Minister of Agriculture/SR.310/M/4/2019) concerning Minimum Technical Requirements for Organic Fertilizers, Biological Fertilizers, and Soil Improvements
- [22] Gomez 1995 "*Statistical procedurs for agricultural research* (Translate by Endang Sjamsuddin and Yustika, Baharsjah S)" 2nd Edn UI Press, Jakarta
- [23] Machay A D, Syers J K and Gregg P E H 1984 Ability of chemical extraction procedures to assess the agronomic effectiveness of phosphate rock material *New Zealand Journal of Agricultural Research* **27** 219 – 230
- [24] Soekartawi and Soeharjo A 2011 *Farming science and research for smallholder development* (Jakarta: UI Press)
- [25] Hardjowigeno S 1985 *Soil Classification. Soil Survey and Land Capability Evaluation* IPB Bogor p 283
- [26] Ponnamperna F M 1978 *Electrochemical Changes In Submerged Soil and the Growth of Rice* IRRI Los Banos Philippines.
- [27] Mullen M D 1999 *Transformation of other elements. In principles and applications soil microbiology* Prentice-Hall New Jersey p 19
- [28] Nyakpa M Y, Lubis A M, Pulung M A, Munawar A G, Hong G B and Hakim N 1988 *Soil Fertility* Lampung University p 258
- [29] Syafruddin 2016 Site specific fertilization of N, P, and K on maize in Gowa Regency South Sulawesi *Journal of the Assessment and Development of Agricultural Technology* **19** 119 – 133
- [30] Heggenstaller A 2016 Crop insights : managing soil pH for crop production. [http://www.pioneer.corn/home/site/us/agronomy/library/managing soilpH/](http://www.pioneer.corn/home/site/us/agronomy/library/managing_soilpH/) Accessed July 10, 2022
- [31] Groot LD and Bogdanski A 2013 *Bioslurry brown gold : a review of scientific literature on the coproduct of biogas production*. Food and Agriculture Organization of the United Nations Rome p 33
- [32] Hartanto Y and Putri CH 2013 *Guidelines for the use and provision, management and utilization of bioslurry (In Indonesian)* Home biogas team (blue), energy home foundation Jakarta p 13

- [33] Sahardi, Herniwati and Djufri F 2014. Crop productivity and financial viability of rice in newly opened paddy fields with various fertilizers in South Sulawesi. *Journal of Agricultural Technology Assessment and Development* **17** 187 – 196.
- [34] Moe K, Moh S M, Hrwe A Z, Kajihara Y and Yamakawa T 2019 *Effects of integrated organic and inorganic fertilizers on yield and growth parameters of rice varieties Rice Science*, 26 309–318 doi : 10.1016/j.rsci.2019.08.005
- [35] Khanafi A, Yafizham and Widjanto D W 2018 The effectiveness of Bio-Slurry and inorganic fertilizer combination on the performance of rice (*Oryza sativa* L) *J Applied Chem. Sci.* **5** 418-423 doi : <https://dx.doi.org/10.22341/jacs.on.00501p418>
- [36] Havlin J L, Beaton J D, Tisdale S L and Nelson W L 2005 *Soil fertility and fertilizers an introduction to nutrient management* 7 th Edition Prentice Hall, New Jersey
- [37] Sposito G 2008 *The chemistry of soils* 2nd Edition Oxford University Press, Inc. New York USA
- [38] Nishio M 2007 *Basic Knowledge of Using Compost and Organic Fertilizers*. Tokyo: Association of Rural and Fishing Cooperation : 213.
- [39] Garnett T, Conn V, Kaiser B N 2009 Root based approaches to improving nitrogen use efficiency in plants *Plant Cell Environ* **32** 1272-1283.
- [40] Liu X W, Wang H Y, Zhou J M, Hu F Q, Zhu D J, Chen Z M and Liu Y Z 2016 Effect of N fertilization pattern on rice yield, N use efficiency and fertilizer-N fate in the Yangtze River basin, *China PLoS One* **11**: e0166002
- [41] Mahmud A J, Shamsuddoha A T M and Haque N 2016 Effect of organic and inorganic fertilizer on the growth and yield of rice (*Oryza sativa* L.) *Natural and Science* **14** 45- 54 doi:10.7537/marsnsj14021607
- [42] Siregar A F and Hartatik W 2010 Application of organic fertilizers in increasing the efficiency of inorganic fertilizers in paddy fields Proceedings of the National Seminar on Agricultural Land Resources : 23-38 [38]
- [43] Zhao wei J L, Xiong W, Zhen L Y, Chuanying Z and Hua-an X 2003 Effect of nitrogen fertilizer rates on uptake and distribution on nitrogen in ratoon rice *Fujian Journal Agriculture Science* **2** 14-29
- [44] Padmanabha I G 2014 Effect of doses of organic and inorganic fertilizers on rice yields (*Oryza sativa* L.) and soil chemical properties in Inceptisols kerambitan Tabanan Bali *E-Jurnal Tropical Agroecotechnology* **3** 41 – 49.
- [45] Widyastuti Y, Satoto and Rumanti I A 2015 Utilization of regression analysis and AMMI for evaluation of yield stability of rice genotypes and the effect of genetic and environmental *Interactions Journal of Agricultural Informatics* **22** 21–27
- [46] Razzaque M M A 1996 Comparative Study on the Effect of Rice Straw Farmyard Manure and Fertilizer Nitrogen on the Growth and Yields of BR11 Rice Thesis Department of Soil Science BAU Mymensingh.
- [47] Kenchaiah A 1997 *Organic Farming in Rice* Thesis Tamil Nadu Agricultural University Coimbatore.
- [48] Satyanarayana V, Prasead P V V, Murthy V R K and Rodty K J 2002 Influence of combined application of farm yard manure and inorganic fertilizers on yield components of irrigated lowland rice *Journal of Plant Nutrition* **25** 2081-2090
- [49] Islam M S, Akhter M M, Rahman M S Q, Banu M B and Khalequzzaman K M 2008 Effect of nitrogen and number of seedlings per Hill on the yield and yield components of T aman Rice (BRRI Dhan 33) *International Journal of Sustainable Crop Production* **3** 61-65
- [50] Rahman S 1991 Influence of organic matter on the yield and mineral nutrition of modern rice and soil properties *Bangladesh Rice Journal* **2** 107-112

- [51] Liu X W, Wang H Y, Zhou J M, Hu F Q, Zhu D J, Chen Z M, and Liu Y Z 2016 Effect of N fertilization pattern on rice yield, N use efficiency and fertilizer-N fate in the Yangtze River basin, China *PLoS One* **11**: e0166002
- [52] Virmani S S 1994 Heterosis and hybrid rice breeding In : Frankel R Monograph on Theoretical and Applied Genetics 22 Springer Verlag, Berlin, NY, London, Paris, Tokyo, Hongkong, Barcelona, Budapest-IRRI, Philipines pp 163-189
- [53] Yang CM, Yang L, Yang Y and Ouyang Z 2004 Rice root growth and nutrient uptake as influenced by organic manure in continuously and alternately flooded paddy soils *Agricultural Water Management* **70** 67-81.
- [54] Ebaid RA, El-Refaee IS 2007 Utilization of rice husk as an organic fertilizer to improve productivity and water use efficiency in rice fields. *African Crop Science Conference Proceedings* **8** 1923-1928
- [55] Rahmad D, Nurmiaty, Halid, Ridwan and Baba B 2022 Characterization growth and production some superior rice varieties *Journal of Agroplanta* **11** 37-45
- [56] Yoshida S 1981 Fundamentals of Rice Crop Science *The International Rice Research Institute Los Banos Laguna Philippines* p 279
- [57] Abdullah B, Tjokrowidodo S and Sularjo 2008 Development and prospect of assembling new types of rice in Indonesia *Journal of Agricultural Research and Development* **27** :1-9
- [58] Mangalassery S, Kalaivanan D and Philip P S 2019 Effect of inorganic fertilisers and organic amendments on soil aggregation and biochemical characteristics in a weathered tropical soil *Journal of Soil Tillage Resaerch* **187** : 144–15
- [59] Sarwar G, Schmeisky H, Hussain N, Mohammad S and Safdar E 2008 Improvement of soil physical and chemical properties with compost application in rice-wheat cropping system *Pakistan Journal of Botany* **40** 275-282
- [60] Ali R I, Awan T H, Ahmad M, Saleem M U and Akhtar M 2012 Diversification of rice based cropping systems to improve soil fertility, sustainable productivity and economics *Journal of Animal and Plant Sciences* **22** 108-112
- [61] Rajni R, Srivastava O P and Rani R 2001 Effect of Integration of Organics with Fertilizer N on Rice and N Uptake *Fertility News* **46** 63-65
- [62] Aktar M S, Hasan, M K S, Adhikery R C and Chowdhury M K 1993 Integrated management of *Sesbania rostrata* and urea nitrogen in rice under a rice - rice cropping system *Ann. Bangladesh Agric* **3** 114-189
- [63] Wijaya A A, Lumbanraja L and Ginting L Y 2015 Test the effectiveness of Organonitrofos fertilizer and its combination with inorganic fertilizers on growth, nutrient uptake and production of cucumber (*Cucumis sativus* L.) in the second growing season on ultisols soil at Meneng Building 3 409-421
- [64] Budianto J 2000 Acceptability of agricultural technology for consumers *Food Crops Research Symposium IV* Food Crops Research Center Bogor pp 12-13

