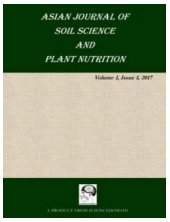

Asian Journal of Soil Science and Plant Nutrition
1(1): 1-10, 2017; Article no.AJSSPN.33267

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Enhanced Growth and Yield of Lowland Rice (*Oryza sativa L.*) with Greenshield Organic-based Fortified Foliar Fertilizer

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJSSPN/2017/33267
Editor(s):
(1) Tancredo Souza, Department of Life Sciences, Centre for Functional Ecology, University of Coimbra, Portugal.
Reviewers:
(1) lukman sale, Usmanu Danfodio University, Sokoto, Nigeria.
(2) Gheorghe Cristian Popescu, University of Pitesti, Romania.
Complete Peer review History: http://www.sciencedomain.org/review-history/18860

Original Research Article

Received 6th April 2017
Accepted 25th April 2017
Published 1st May 2017

ABSTRACT

This study was conducted from December 2015 to March 2016 at the rice field area of the University of Southeastern Philippines, Mabini Campus, Compostela Valley Province. It was conducted to evaluate the bioefficacy of Greenshield Organic-Based Fortified Foliar Fertilizer (GOFFF) on the growth and yield of lowland rice; to determine the best fertilizer combinations for the optimum yield of rice; and to evaluate the economic benefits of using Greenshield Organic-Based Fortified Foliar Fertilizer for rice.

The experiment was laid out in a Randomized Complete Block Design (RCBD) having six treatments and replicated three times. The treatments were: Treatment 1 (Untreated), Treatment 2 (Recommended rate of NPK fertilizer/Ha), Treatment 3 (½ of Recommended NPK/Ha), Treatment 4 (Greenshield Organic-Based Fortified Foliar Fertilizer (GOFFF) at 100 ml/16 li of water), Treatment 5 (½ Recommended NPK + GOFFF, and Treatment 6 Recommended NPK + GOFFF.

The result of the statistical analysis revealed that the agronomic characteristics and yield of Rice (Rc82) were significantly affected by Greenshield Organic-Based Fortified Foliar Fertilizer (GOFFF) at 5% level of significance such as plant height, leaf color, number of tillers, number of productive tiller, number of days to maturity, grains per panicle in $20m^2$ and weight of 1000 grains and grain yield per hectare.

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It was observed that using Greenshield Organic-Based Fortified Foliar Fertilizer (GOFFF) alone enhanced the growth and yield of rice (Rc82) with an ROI of 71.39%. Moreover, T6 Recommended NPK + Greenshield Organic-Based Fortified Foliar Fertilizer (GOFFF) recorded the highest plant height by 24%, leaf color, number of tillers and productive tillers by 50%, number of grains per panicle, weight of 1,000 grains and yield of 4.59 tons/ha. Although, it has the longest time of maturity.

Keywords: Rice; organic-based; foliar fertilizer; yield; growth; Oryza sativa L.

1. INTRODUCTION

Rice is a cereal grain (*Oryza sativa L.*) of the grass family *Graminae*. Rice is central to the lives of billions of people around the world. Rice is the staple food of 2.5 billion people and growing rice is the largest single use of land for producing food, covering 9% of the earth's arable land [1]. In the Philippines, about a greater percentage of the population is engaged in farming where rice production has always been paramount upheld and significantly upgraded by tremendous research studies to improve its production. More than 70% of the world's rice is produced from 50% of the world's rice land that are irrigated. In the South and Southeast Asia alone, irrigated areas accounted for approximately one–third of the world's total farm area, thereby contributing for about 50% of the world's total production [2,3].

China is the world's largest producer of rice having annual output of 204.3 million metric ton. Nearly half of country's total grain output meets by rice. India and Indonesia is second and third largest producer. Philippines ranked 7th place of top producing country in the world, which had 18.0 million metric ton annually in 2013 statistics. In Philippines, Nueva Ecija ranked number (one), by producing rice which have a total of 1,930,996 metric tons, followed by Isabela, Pangasinan, Cagayan, Ilo-ilo, Tarlac, Camarines Sur, Cotabato, Leyte, Negros Occidental in 2014 statistics by Bureau of Agriculture Statistics [4,5]. Fast growing population is one of the factors contributing to rice shortage. Typhoons are also a major reason for poor rice production. Located off the eastern edge of the Asian continent, the Philippines bears the brunt of numerous typhoons, making rice production difficult and risky. In addition, pests and diseases as well as fertilizer management remained to be the major problems.

Fertilizer application, both organic and inorganic, contains nutrient that are necessary for the crops to support their life cycle. Soil does not often provide enough nutrients needed by the crops hence they need application of foliar fertilizer. Foliar fertilizer application is advantageous since there is less fertilizer usually required, avoid injury in the seedling roots from application of dry fertilizer, and better distribution of small quantities of fertilizer is secured.

Hence, this study was conducted to evaluate the bioefficacy of Greenshield Organic-Based Fortified Foliar Fertilizer (GOFFF) on the growth and yield of lowland rice; to determine the best fertilizer combinations for the optimum yield of rice; and to evaluate the economic benefits of using Greenshield Organic-Based Fortified Foliar Fertilizer for rice.

2. MATERIALS AND METHODS

2.1 Study Area

The study was conducted at the research area of the University of Southeastern Philippines, Tagum-Mabini Campus, Mabini Unit, Mampising, Compostela Valley Province, from December 2015 – March 2016. Before the conduct of the study, soil samples were taken at random from the experimental area at a depth of 0-30cm using soil auger. The soil sample was pulverized, air dried and analyzed at the Regional Soil Laboratory of the Department of Agriculture, Agdao, Davao City. The study was conducted using Randomized Complete Block Design (RCBD) with six (6) treatments and replicated three (3) times. Each plot has a dimension of 4 x 5 meters with 18 plots for a total of 360 sq. m. area. The treatments were: T1 − Untreated Check (no fertilizer); T2 − Recommended rate (RR) of NPK fertilizer/Ha; T3 − ½ RR NPK/Ha; T4–Greenshield Organic-Based Fortified Foliar Fertilizer (GOFFF) at 100 ml/16 li of water; T5 − ½ RR NPK + GOFFF; and T6 − RR NPK + GOFFF. The transplanting material used was PSB Rc 82 rice variety.

2.2 Cultural Management

The experiment has an area of 360 m^2 divided into 18 plots with a size of 4x5 m^2. Each plot was thoroughly-plowed and properly rotavated using mechanical rotavator two to three times until it was ready for transtransplanting. The dike was constructed in every plot. Covering of cellophane of the dike was done in every plot to avoid contamination of treatments. In preparing the seedbed, the area was rotavated three times. The dike was constructed side by side in every plot. The plot was leveled properly into 1.5 meter wide. Seedlings were irrigated five days after sowing and when the seedlings were about centimeters high. Application of fertilizer was done seven days after sowing. The seedlings were pulled out at the age of 20 DAT (Days after transplanting) and bandled into convenient size. A bamboo slat was used for marking, done crosswise for uniform distance. Rice seedlings were transplanted into each plot at 2 to 3 seedlings per hill at transplanting distance of 20 cm by 20 cm. Complete fertilizer and all recommended rate of organic fertilizer were applied basally before transtransplanting in every plot depending on the treatment. Application of nitrogen fertilizer (46-0-0) was done by side dressing from 41 days after transtransplanting, and 70 days after transtransplanting as topdressing (16-20-0-24S) following the recommended rate based on soil analysis. GOFFF (Greenshield Organic-Based Fortified Foliar Fertilizer) was applied to the rate of 100 ml/ 16 li of water every ten days based on different treatments. All plots were irrigated uniformly 3–4 cm at 8 days after transtransplanting and maintained for 2 times in 3 weeks. Continuous irrigation was done to supply the requirement of plant. The field was kept free from weeds through constant weeding during the growth period of the crop to avoid nutrient competition. Insecticides and pesticides were applied at 15–20 days interval depending on severity of pest and disease incidence. Harvesting was done when 80% - 90% of the grains were fully ripened. The area was drained with water 10 days before harvesting and harvested by the use of sickle knife and threshed manually. Care was done in order to prevent grain damage. The grains were dried partially and finally the grains were dried at 14% moisture content.

2.3 Data Gathered

Plant height (cm) was measured in centimeters from the base up to the tip of the highest leaf at 30, 60 and 90 DAT (days after transplanting). The leaf color was taken from ten randomly selected sample plants using a leaf color chart by placing the middle part of the third leaf on the top of the LCC (leaf color chart) color strips for comparison at 30 days interval. Number of Tillers was taken from one linear meter per plot at forty (40) to forty five (45) DAT (days after transplanting). Number of Productive Tillers was taken at ninety (90) DAT (days after transplanting, from 10 hills per plot picked at random. Number of days to maturity was recorded at the time when 85% of the grains in the panicle show golden yellow color. Number of grains per panicle refers to the number of grains per panicle that have fully developed spikelet. This was determined during harvesting time, from 10 samples randomly selected in every replication. Weight of 1000 grains (gram) was taken by weighing the 1000 grains that were gathered in every replication with moisture content of 14%. Grain yield refers to the average yield per treatment at 14% moisture content (MC). The Grain Yield (t / ha) is computed by dividing the Plot Yield (kg) by the Plot size (sq.m.) multiplied by 10,000 sq.m. over 1,000 kg.

The return of investment (ROI) of the different treatments were computed based on the following formula by considering all costs resources used like labor, materials, and land rentals. The ROI is computed by dividing the Net income by the Production cost multiplied by 100.

The different data gathered were analyzed through Analysis of Variance (ANOVA) following the Randomized Complete Block Design (RCBD) and effectiveness of different treatments was determined by comparing means using the Honest Significant Difference (HSD) Test at 5% level of significance.

3. RESULTS AND DISCUSSION

3.1 Plant Height (cm)

The Analysis of variance (ANOVA) revealed that height at 30, 60 and 90 DAT (days after transplanting) was significantly affected by the Greenshield Organic-based Fortified Foliar Fertilizer (GOFFF) (Table 1).

At 30 DAT (days after transplanting), Treatment 6 (Recommended NPK + GOFFF) had the tallest plant height with a mean of 62.33 cm. It is comparable with treatment 2 (recommended rate of NPK fertilizer/Ha) with a mean of 60.67 cm,

T3 (½ of Recommended NPK/Ha) and T5 (½ Recommended NPK + GOFFF (T3+T4) with mean heights of 60.52 cm, 60.62 cm respectively. The lowest height of rice was observed in T1 (Untreated) with 55.67 cm and T4 (GOFFF at 100 ml/16 li of water) with 57.64 cm. At 60 DAT plant height of rice was also significantly affected by Greenshield Organic-based Fortified Foliar Fertilizer (GOFFF). Treatment 1 (Untreated), got the shortest plant height with the mean of 82.79. This is followed by T3 (½ of Recommended NPK/Ha), T2 (recommended rate of NPK fertilizer/Ha), T4 (GOFFF at 100 ml/16 li of water). The highest height was obtained in T6 (Recommended NPK + GOFFF), with a mean of 91.37 cm which is also comparable to T5 (½ Recommended NPK + GOFFF). At 90 DAT, Treatment 6 (Recommended NPK + GOFFF (T2+T4) also got higher plant height compared to T3 (½ of Recommended NPK/Ha), T4 (½ of Recommended NPK/Ha), T2 (Recommended rate of NPK fertilizer/Ha), and T1 (Untreated) with means of 95.88 cm, 92.2 cm, 93.12 cm, 91.1 cm, respectively. This is similar in T5 (½ Recommended NPK + GOFFF) with a mean of 103.81 cm. Hence, T6 (Recommended NPK + GOFFF) increased the plant height of rice as much as 24% higher than untreated plants.

3.2 Leaf Color

Table 2 presents the leaf color level of lowland rice (Rc82) at 30 and 60 DAT (days after transplanting) as affected by Greenshield Organic-based Fortified Foliar Fertilizer (GOFFF). The ANOVA revealed that the Greenshield Organic-based Fortified Foliar Fertilizer (GOFFF) has high significant effect on the leaf color of rice.

Table 1. Means on the plant height of rice at 30, 60 and 90 DAT (days after transplanting as affected by Greenshield Organic-based Fortified Foliar Fertilizer (GOFFF)

Treatments	Plant height (cm) Days after transplanting		
	30 DAT**	60 DAT**	90 DAT**
T1 - Untreated	55.56^{c}	82.79^{c}	91.1^{c}
T2 - recommended rate of NPK fertilizer/Ha	60.67^{ab}	84.35^{bc}	93.12^{bc}
T3 - ½ of Recommended NPK/Ha	60.52^{ab}	85.85^{bc}	95.88^{bc}
T4 – GOFFF (Greenshield Organic-Based Fortified Foliar Fertilizer) 100 ml/16 li water	57.64^{bc}	83.81^{c}	92.2^{bc}
T5 - ½ Recommended NPK + GOFFF	60.86^{ab}	88.55^{ab}	103.81^{ab}
T6 - Recommended NPK + GOFFF	62.33^{a}	91.37^{a}	113.65^{a}
CV (%)	1.88	1.75	4.38

***Highly significant*

Means within the same column with the same letter are not significantly different at 1% level using HSD

Table 2. Means on the leaf color of rice at 30 and 60 DAT (days after planting) as affected by Greenshield Organic-based Fortified Foliar Fertilizer (GOFFF)

Treatments	Plant color Days after transplanting	
	30 DAT**	60 DAT**
T1 - Untreated	3.00^{c}	3.77^{c}
T2 - recommended rate of NPK fertilizer/Ha	3.97^{a}	4.94^{a}
T3 - ½ of Recommended NPK/Ha	3.86^{b}	4.97^{a}
T4 - GOFFF (Greenshield Organic-Based Fortified Foliar Fertilizer) 100 ml/16 li water	3.94^{ab}	4.37^{ab}
T5 - ½ Recommended NPK + GOFFF	3.98^{a}	5.00^{a}
T6 - Recommended NPK + GOFFF	4.00^{a}	5.00^{a}
CV (%)	0.90	7.36

***Highly significant*

Means within the same column with the same letter are not significantly different at 1% level using HSD

At 30 DAT, it was observed that T6 (Recommended NPK + GOFFF), T5 (½ Recommended NPK + GOFFF), T4 (GOFFF (Greenshield Organic-Based Fortified Foliar Fertilizer at 100 ml/16 li of water), and T2 (Recommended rate of NPK fertilizer/Ha) had greater leaf color than T3 (½ Recommended NPK/Ha) and T1 (Untreated) with the lowest leaf color levels. At 60 DAT, the result showed that all basal and foliar fertilizer applications have greater leaf color levels than the untreated plants. The Treatments 6 (Recommended NPK + GOFFF), 5 (½ Recommended NPK + GOFFF), 4 (GOFFF (Greenshield Organic-Based Fortified Foliar Fertilizer at 100 ml/16 li of water), 3 (½ Recommended NPK/Ha) and 2 (Recommended rate of NPK fertilizer/Ha) were comparable to each other with a range of 4.37 to 5. Commercial fertilizer is one of the major aspects in plant production [6,7]. Nitrogen, Phosphorus and Potassium are all essential elements of plants for favorable result. Therefore, the application of recommended inorganic, organic and foliar fertilizer can cause deep green color in the leaves of rice. The production of rice would depend largely on the amount of fertilizer to promote green color of leaves and seed development [8,9].

3.3 Number of Tillers

The ANOVA revealed that there were significant differences on the average number of tillers as affected by Greenshield Organic-based Fortified Foliar Fertilizer (GOFFF) (Table 3).

Treatment 6 (Recommended NPK + GOFFF) had the highest number of tillers, comparable to Treatments 5 (½ Recommended NPK+GOFFF) and 2 (recommended rate of NPK fertilizer/Ha). Treatment 4 (Greenshield Organic-Based Fortified Foliar Fertilizer at 100 ml/16 li of water), 3 (½ of Recommended NPK/Ha), and 1 (Untreated) have similar effects with the least tillers produced. This implies that the application of basal NPK combined with foliar fertilizer application enhanced the number of tillers of rice. Rice plant requires a large amount of nitrogen at mid-tillering stage to maximize the number of panicle. Furthermore, nitrogen increases the number of tillers [10]. Foliar application of potassium gave better number of tillers of rice [11].

3.4 Number of Productive Tillers

The average number of productive tillers of Rc82 was counted before harvesting the rice plant. Analysis of Variance (ANOVA) in Table 4 showed that the number of productive tillers was significantly affected by the application of Greenshield Organic-based Fortified Foliar Fertilizer (GOFFF) at 90 DAT (days after transplanting).

This further showed that T6 (Recommended NPK + GOFFF) which is also comparable to T5 (½ Recommended NPK+GOFFF) have the most productive tillers by 50% compared to the rest of the treatments. Though T5 (½ Recommended NPK+GOFFF) was statistically the same with T2 (Recommended rate of NPK fertilizer/Ha), T3 (½ of Recommended NPK/Ha) and T4 (GOFFF at 100 ml/16 li of water) on productive tillers. While the untreated (T1) with the lowest tiller was also

Table 3. Number of tillers of rice as affected by Greenshield Organic-based Fortified Foliar Fertilizer (GOFFF) at 45 DAT (days after transplanting)

Treatments	Replication			Mean no. of tillers*
	I	II	III	
T1 – Untreated	15.7	14.7	18.5	16.3^{c}
T2 - recommended rate of NPK fertilizer/Ha	19.5	19.8	21.8	20.37^{ab}
T3 - ½ of Recommended NPK/Ha	17.2	18	16.8	17.33^{bc}
T4 - GOFFF (Greenshield Organic-Based Fortified Foliar Fertilizer) 100 ml/16 li water	19.2	16.2	16.8	17.42^{bc}
T5 - ½ Recommended NPK+GOFFF	20.8	21.7	20.4	20.33^{ab}
T6 - Recommended NPK + GOFFF	22.0	23.5	23.7	23.33^{a}

*CV= 7.53%; *Significant*

Means within the same column with the same letter are not significantly different at 1% level using HSD

Table 4. Number of productive tillers of rice per 20 m^2 as affected by Greenshield Organic-based Fortified Foliar Fertilizer (GOFFF)

Treatments	Replication			Mean no. of productive tillers*
	I	II	III	
T1 – Untreated	14.50	13.00	14.50	14.00^{bc}
T2 - recommended rate of NPK fertilizer/Ha	11.86	17.00	14.00	13.86^{c}
T3 - ½ of Recommended NPK/Ha	16.25	16.7	14.00	15.65^{bc}
T4 - GOFFF (Greenshield Organic-Based Fortified Foliar Fertilizer) 100 ml/16 li water	17.00	15.25	13.00	15.08^{bc}
T5 - ½ Recommended NPK+GOFFF	19.00	18.86	19.25	19.04^{ab}
T6 - Recommended NPK + GOFFF	20.00	21.86	22.14	21.33^{a}

*CV= 10.84%; *Significant*

Means within the same column with the same letter are not significantly different at 1% level using HSD

comparable to T2 (Recommended rate of NPK fertilizer/Ha), T3 (½ of Recommended NPK/Ha) and T4 (GOFFF at 100 ml/16 li of water). Rice plant requires a large amount of nitrogen at mid-tillering stage to maximize the number of panicle. Furthermore, nitrogen increases the number of tillers [10]. Foliar application of potassium gave better number of tillers of rice [11].

3.5 Number of Days to Maturity

The number of days to maturity of rice (Rc82) was significantly affected by Greenshield Organic-Based Fortified Foliar Fertilizer (GOFFF) which is presented in Table 5.

It was observed that those plants with no fertilizer application were first to mature within 96 DAT (days after transplanting). This was followed by treatments T2 (Recommended rate of NPK fertilizer/Ha), T3 (½ of Recommended NPK/Ha), T4 (GOFFF at 100 ml/16 li of water), and T5 (½ Recommended NPK+GOFFF). Moreover, Treatment 6 (Recommended NPK + GOFFF) had the longest days to mature. This implies that fertilizer application hastens maturity of rice. Maturity is strongly affected by air temperature and water temperature. Nitrogen deficiency somewhat hastened maturity and heavy application delays it slightly [12].

3.6 Number of Grains per Panicle

Table 6 shows the data on the number of grains per panicle. The result showed that there were significant differences between treatments means.

It was observed that basal application and foliar fertilizer applications (T2- recommended rate of NPK fertilizer/Ha), T3 (½ of Recommended NPK/Ha), T4 (GOFFF at 100 ml/16 li of water), T5 (½ Recommended NPK+GOFFF - T4+T3) and T6 (Recommended NPK + GOFFF - T2+T4) had higher number of grains per panicle compared to the untreated (T1). The result indicates that using Greenshield Organic-based Fortified Foliar Fertilizer (GOFFF) significantly increased the number of grains per panicle in lowland rice. Rice plant requires a large amount of nitrogen at mid-tillering stage to maximize the number of grains in panicle [10]. Foliar sprays are great supplement to boost flavors, sweetness, mineral density and yield of crops [13]. Plants applied with correct amount of fertilizer resulted to more filled grains [9]. Nitrogen promotes rapid growth and increases leaf size and spikelet number per panicle. Nitrogen affects all parameters that contribute to the yield [14,15,16].

3.7 Weight of 1000 Grain (Gram)

Table 7 presents the weight of 1000 grains. Statistically, the application of Greenshield Organic-based Fortified Foliar Fertilizer (GOFFF) significantly affected the grain weight of rice.

Treatment 6 (Recommended NPK + GOFFF), obtained the highest weight of 1,000 grains with a mean of 23.67 which is comparable to T5 (½ Recommended NPK+GOFFF), T3 (½ of Recommended NPK/Ha), and T2 (Recommended rate of NPK fertilizer/Ha), while T1 (Untreated) and T4 (GOFFF at 100 ml/16 li of water) got lower weights per 1,000 grains of rice. Fertilizer application increases plant height, plant yield, plant growth, quality for fruits and weight of fruits which are enhanced through N-P-K [17]. During vegetative and productive stage of the plant, the available nutrients were absorbed and apparently development of the size of the spikelet takes place which contributed to the increase of grain size [18].

Table 5. Number of days to maturity of rice as affected by Greenshield Organic-based Fortified Foliar Fertilizer (GOFFF)

Treatments	Replication			Mean days to maturity**
	I	II	III	
T1 – Untreated	96	96	96	96[c]
T2 - recommended rate of NPK fertilizer/Ha	99	99	99	99[ab]
T3 - ½ of Recommended NPK/Ha	99	99	99	99[ab]
T4 - GOFFF (Greenshield Organic-Based Fortified Foliar Fertilizer) 100 ml/16 li water	97	99	98	98[bc]
T5 - ½ Recommended NPK+GOFFF	99	98	99	99[ab]
T6 - Recommended NPK + GOFFF	100	100	100	100[a]

*CV= 0.66%; **Highly significant*

Means within the same column with the same letter are not significantly different at 1% level using HSD

Table 6. Number of grains per panicle of rice as affected by Greenshield Organic-based Fortified Foliar Fertilizer (GOFFF)

Treatments	Replication			Mean no. of grain/ panicle**
	I	II	III	
T1 – Untreated	108	110	95	104.7[b]
T2 - recommended rate of NPK fertilizer/Ha	130	122	134	128.9[a]
T3 - ½ of Recommended NPK/Ha	118	124	130	124.4[a]
T4 - GOFFF (Greenshield Organic-Based Fortified Foliar Fertilizer) 100 ml/16 li water	128	120	126	125.0[a]
T5 - ½ Recommended NPK+GOFFF	130	124	128	127.5[a]
T6 - Recommended NPK + GOFFF	130	129	130	130.1[a]

*CV= 3.30%; **Highly significant*

Means within the same column with the same letter are not significantly different at 1% level using HSD

Table 7. Weight of 1000 grains (gram) of rice as affected by Greenshield Organic-based Fortified Foliar Fertilizer (GOFFF)

Treatments	Replication			Mean weight of 1,000 grains*
	I	II	III	
T1 – Untreated	20.00	19.25	21.70	20.32[bc]
T2 - recommended rate of NPK fertilizer/Ha	21.80	20.00	21.70	21.17[abc]
T3 - ½ of Recommended NPK/Ha	23.00	20.50	20.00	21.17[abc]
T4 - GOFFF (Greenshield Organic Based Fortified Foliar Fertilizer) 100 ml/16 li water	20.30	19.50	20.00	19.93[c]
T5 - ½ Recommended NPK+GOFFF	23.00	22.80	22.30	22.7[ab]
T6 - Recommended NPK + GOFFF	24.00	23.00	24.00	23.67[a]

*CV= 4.03%; *Significant*

Means within the same column with the same letter are not significantly different at 5% level using HSD

3.8 Grain Yield (ton/ha)

Table 8 showed that the yield of rice was highly affected by Greenshield Organic-based Fortified Foliar Fertilizer (GOFFF).

Results indicate that both basal and foliar fertilizer applications increased the yield of rice. Treatment 6 (Recommended NPK + GOFFF) got the highest yield of 4.59 tons/ha. Nitrogen is an integral component of many compounds as protein and amino acids which are essential for plant growth and impart deep green color of the leaves [19]. Like most other crops, rice needs fertilizer to facilitate growth and improve yield. Foliar Spraying increases the yield of leguminous

Table 8. Grain yield (kg/plot) and (ton/ha) of rice as affected by Greenshield Organic-based Fortified Foliar Fertilizer (GOFF)

Treatments	kg/plot**	ton/ha**
T1 - Untreated	6.57[c]	3.29[c]
T2 - recommended rate of NPK fertilizer/Ha	7.58[a]	3.79[a]
T3 - ½ of Recommended NPK/Ha	7.9[ab]	3.95[a]
T4 - GOFFF (Greenshield Organic-Based Fortified Foliar Fertilizer) 100ml/16li water	7.17[ab]	3.58[ab]
T5 - ½ Recommended NPK + GOFFF	8.5[a]	4.25[a]
T6 - Recommended NPK + GOFFF	9.17[a]	4.59[a]
CV (%)	7.82	3.91

***Highly significant*

Means within the same column with the same letter are not significantly different at 1% level using HSD

Table 9. Economic analysis of rice as affected by Greenshield Organic-based Fortified Foliar Fertilizer (GOFFF)

Treatment	Grain yield (kg/20m^2)	Price/kilo (Pesos)	Gross income	Total expenses	Net income	ROI
T1	6570	20	13140	37464	24324	64.92
T2	7580	20	15160	49441	33641	68.04
T3	7900	20	15800	49570	35770	68.13
T4	7170	20	14340	50114	35774	71.39
T5	8500	20	17000	49057	49057	65.35
T6	9170	20	18340	50437	50437	63.64

crop particularly in the case of minor elements needed by the plants in small amount [20,21]. Rice plants obtain much of their required Phosphorus and Potassium from the soil, crop residues, organic amendments, and irrigation water; but the phosphorus and potassium supply from this naturally occurring, indigenous source are typically insufficient to sustain high rice yield [22]. Supplemental phosphorus and potassium from fertilizer are essential for sustaining high and profitable rice yields. Foliar sprays are great supplement to boost flavors, sweetness, mineral density and yield of crops [13]. Foliar application of potassium gave better yield of rice [11]. Moreover, inorganic foliar fertilizer gave higher yields in maize than applied with organic fertilizer and yield improved only when mixed together [23]. Inorganic fertilizers have higher yields than organic fertilizers in cucumber and okra [24]. Integration of both organic and inorganic fertilizers also increased yield of pepper [25].

3.9 Economic Analysis

Table 9 above present the data on the economic analysis of rice as affected by Greenshield Organic-based Fortified Foliar Fertilizer (GOFFF).

Results implied that T4 (GOFFF at 100 ml/16 li of water), got the highest ROI, followed by T2 (Recommended rate of NPK fertilizer/Ha), T3 (½ of Recommended NPK/Ha) and T5 (½ Recommended NPK + GOFFF), while lowest ROI were observed in T6 (Recommended NPK +GOFFF) and T1 (Untreated Check (no fertilizer). Hence, GOFF alone enhanced the income of rice. In maize, application of inorganic fertilizer alone was more economical than sole foliar fertilizer or in combination [23].

4. CONCLUSION

The experiment on the Effects of Greenshield Organic-based Fortified Foliar Fertilizer on the Growth and Yield of Lowland rice (*Oryza sativa*) was conducted at the University of Southeastern Philippines Tagum-Mabini Campus, Mabini Unit, Pindasan, Mabini Compostela Valley province from December 2015 to March 2016. The objectives of the study were to evaluate the bioefficacy of GOFFF (Greenshield Organic-based Fortified Foliar Fertilizer) on the growth and yield of lowland rice; to determine the best fertilizer combinations for the optimum yield of rice; and to evaluate the economic benefits of using GOFF for rice. The experiment was laid out in a Randomized Complete Block Design with six treatments and replicated three times. The treatments were: T1 (Untreated Check (no fertilizer), T2 (Recommended rate of NPK

fertilizer/Ha), T3 (½ of Recommended NPK/Ha), T4 (GOFFF at 100 ml/16 li of water), T5 (½ Recommended NPK + GOFFF), and T6 (Recommended NPK +GOFFF). All data were analyzed through Analysis of Variance and the differences among treatments means were compared using the HSD.

Results revealed that there were significant differences in the agronomic characteristics of lowland rice (PSB Rc82) like plant height, leaf color, number of tillers, and number of days to maturity. The weight of 1000 grains, number of productive tillers, grains per panicle, and grain yield were also significantly affected by Greenshield Organic-based Fortified Foliar Fertilizer. Results showed the height of rice was increased by T6 (Recommended NPK +GOFFF) as much as 24% higher than untreated. Highest leaf color levels were also obtained in T6 (Recommended NPK +GOFFF) and T5 (½ Recommended NPK + GOFFF). The number of tillers and productive tillers were also increased by 50% in T6 (Recommended NPK +GOFFF) which is comparable to T5 (½ Recommended NPK + GOFFF). Both basal and foliar fertilizer application also hastens the days of maturity of rice as it matured longer than untreated plants. All fertilizer treatments also have greater number of grain per panicle of rice than untreated plants. This showed that GOFFF (Greenshield Organic-based Fortified Foliar Fertilizer) alone could enhance grains of rice. Furthermore, in terms of yield, still basal and foliar fertilizer applications got higher number of grains per panicle and yield of rice. T6 (Recommended NPK +GOFFF) got the highest weight of 1,000 grains and yield of 4.59 tons/ha. However, economic analysis revealed that GOFFF (Greenshield Organic-based Fortified Foliar Fertilizer) alone increased the ROI (Return of Investment) of 71.39% in rice production.

Based on the result of the study, T6 (Recommended NPK +GOFFF) increased the growth and yield of rice, though GOFFF (Greenshield Organic-based Fortified Foliar Fertilizer) alone enhanced rice production with ROI (Return of Investment) of 71.39%. Hence, either basal and foliar application or GOFFF (Greenshield Organic-based Fortified Foliar Fertilizer) alone is highly recommended for the optimum production of rice.

ACKNOWLEDGEMENTS

The authors extend gratitude to the R&A company for the product used and the University of Southeastern Philippines, Tagum-Mabini Campus, Mabini Unit for the research area.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
http://sciencedomain.org/review-history/18860