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Original Article

Response of Lowland Rice NSIC Rc308 (*Oryza sativa L.*) to Application of Commercial Organic and Inorganic Fertilizers

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ABSTRACT

The study evaluated the effects of combined application of commercial organic and inorganic fertilizers on the growth and yield performance of lowland rice NSIC Rc308, determine the appropriate level of application and evaluate its profitability by using different levels of organic and inorganic fertilizers. The experimental plots were laid out in a Randomized Complete Block Design (RCBD) with three replications and six treatments as follows: T_0 = No fertilizer application (control), T_1 = 120-60-60 kg ha^{-1} N, P_2O_5, K_2O, T_2 = 10 bags ha^{-1} Plantmate Organic Fertilizer (POF) only, T_3 = 10 bags ha^{-1} POF + Prime Emulsifiable Concentrate (EC) 4 liters ha^{-1}, T_4 = 10 bags ha^{-1} POF + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O and T_5 = 5 bags ha^{-1} POF + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O. It was hypothesized that combined application of organic and inorganic fertilizers can improve rice productivity and increase income. Application of commercial organic and inorganic fertilizers significantly affected the number of nodal roots and grain yield than those unfertilized plants. However, inorganic fertilized plants significantly extended their heading and maturity period, taller plant height, high leaf area index (LAI), heavier straw, more nodal roots, heavier shoot dry weight and higher grain yield than unfertilized control. Plants applied with ten bags ha^{-1} POF + 4 liters ha^{-1} Prime EC produced higher grain yield (3.03 tha^{-1}) and net income of PhP 24,743.00 ha^{-1}. Therefore, combined application of POF + Prime EC is recommended for lowland rice production.

KEYWORDS: *inorganic fertilizer, lowland rice, nodal roots, organic, Plantmate, response*

1 INTRODUCTION

Rice *(Oryza sativa L.)* is an agronomic crop that is considered staple food for the growing Filipino populace. This is grown all over the country in both irrigated lowland, rainfed lowland and upland ecosystems. Among the previously mentioned ecosystems, irrigated lowland provides better production compared to other ecosystems because of the availability of water throughout the entire cropping season. In addition, the adoption of effective nutrient management strategies to this ecosystem is the major attribute for the increasing rice productivity. In rice production under lowland conditions, fertilizer application plays a significant role in increasing rice productivity. It supplies an essential nutrient needed for plant growth and development. Fertilizers in various types such as organic and inorganic are both available in the local market. Inorganic fertilizers are usually given as an immediate remedy to correct nutrient deficiency. Its application increases grain productivity, however, its utilization dropped markedly because of being expensive thereby not affordable to marginal farmers. Thus, marginal farmers cannot use them in their rice production undertakings.

Many farmers are looking for locally available alternatives that can supply the needed nutrients. The use of locally available organic fertilizer not only makes the soil fertile but also improves soil organic matter content, which makes it ideal for planting. Moreover, this does not upset the balance in the soil, as it does not leave behind any hazardous compound (Javier, 2001). Two new commercial organic fertilizer products called Plantmate Organic Fertilizer (POF) and Prime Emulsifiable Concentrate (EC) are now available in the market. POF contains 22 beneficial microorganisms categorized as follows: bacteria (7), actinomycetes (2), bacillus sp. (3), nitrifiers (5) and thermophilic fungi (5) that are mainly used to enhance decomposition of polysaccharides, enzyme production and nutrient transformation (Njomo, 2018) which contribute to plants' proliferation and optimal yield. It contains 2% N, 3% P and 3% K, micronutrients, probiotics and organic acids that increase plant resistance against diseases, enzymes and amino acids that speed up plant development. It is a combination of plant and animal wastes thus, making it an excellent soil conditioner. It provides good soil tilt, and enhances the cation exchange capacity of the soil. POF contains N-fixers and other species that can convert inorganic elements that are readily absorbable by plants. Moreover, it contains substantial humus, which improves water-holding capacity of the soil (Richfund International Co. Ltd., 2015). Prime EC is a scientifically formulated bio-organic liquid fertilizer containing highly absorbable macro-nutrients (N, P, K, Ca and Mg) and micro nutrients (S, Zn, B, Fe and Mo), and trace elements including 10% humid acid, 1.5%

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organic acid, 8.25% amino acid and 5.5% growth promotants. However, this foliar fertilizer contains 10% total nitrogen, 6% total phosphorus, 4% total potassium, 3.5% Calcium and 2.75% Magnesium (Richfund International Co. Ltd., 2015).

Application of organic fertilizer alone requires higher quantity to compensate the effects of inorganic fertilizers to improve crop productivity. Hence, adoption of improved nutrient management through combined application of commercial organic and inorganic fertilizers is necessary in order to solve rice insufficiency problem and reduce the utilization of chemical fertilizers that might not affect the entire gamut of society and the environment. Then, it is hypothesized that improved or integrated nutrient management increases crop production and/or yield and apparently net income especially in lowland rice. The combined application of POF and inorganic fertilizers can be an effective technique to provide higher rice productivity. Although, application of either organic or inorganic fertilizers has been extensively studied, the combined utilization of POF and inorganic fertilizer has only very limited information available considering that this product is newly introduced in the market. Consequently, it is very important to study the effect of this practice in order to generate more information that can help farmers to increase rice production and attain rice self-sufficiency while protecting the environment.

Objectives of the study

The study aimed to determine the effects of combined application of commercial organic and inorganic fertilizers on the growth and yield performance of lowland rice NSIC Rc308; identify the appropriate level of commercial organic and inorganic fertilizer combination that can give optimum grain yield of lowland rice; and evaluate the cost and return of lowland rice production using commercial organic and inorganic fertilizers.

2 MATERIALS AND METHODS

Land Preparation

Land preparation was conducted at the experimental area of the Department of Agronomy (DA), College of Agriculture and Food Science (CAFS), Visayas State University (VSU), Visca, Baybay City, Leyte from August 8, 2016 to December 01, 2016. An area of 246.5 m^2 was prepared by puddling at weekly interval to incorporate the weeds and level the soil for even distribution of water. After the last puddling, dikes were constructed to contain the treatment plots and avoid contamination of treatments. Drainage canals were established along the experimental area and in between replication to drain excess water during rainy days. These also served as irrigation canals to supply water during the dry period.

Soil Sampling and Analysis

Before planting, 10 soil samples were randomly collected at a depth of 0-30 cm from the experimental site (Baoy and Bañoc, 2017). These were composited, air-dried, pulverized and sieved using a 2 mm wire mesh (Rallos et al., 2017) and sent to Central Analytical Services Laboratory (CASL), PhilRootcrops, Visayas State University (VSU), Visca, Baybay City, Leyte. The samples were analyzed for soil pH (Potentiometric Method at 1:1 soil-water ratio, PCARR, 1980), total N (Kjedahl Method, ISRIC, 1995), organic matter (Walkley-Black Method, Nelson and Sommers, 1982), available P (Olsen Method, Olsen et al., 1954), and exchangeable K (ammonium acetate) extraction method using atomic absorption spectrophotometry, ISRIC, 1995.

After harvesting, five soil samples were gathered from each treatment plot. These were composited, processed and analyzed for the same soil parameters mentioned earlier following the same procedure as of the initial soil analysis.

Experimental Design and Field Layout

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Each replication was subdivided into six treatment plots with an area of 10 m^2 (5 m x 2 m) $plot^{-1}$. A 1 m and 0.5 m alleyways separated replications and treatment plots, respectively, to facilitate farm operations and data gathering. The treatments were as follows:

- T_0 - No fertilizer application (control)
- T_1 -120-60-60 kg ha^{-1} N, P_2O_5, K_2O (inorganic fertilizer)
- T_2 -10 bags ha^{-1} Plantmate Organic Fertilizer (POF)
- T_3 -10 bags ha^{-1} POF + 4 liters ha^{-1} Prime EC (Inorganic fertilizer)
- T_4 -10 bags ha^{-1} POF + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O
- T_5 -5 bags ha^{-1} POF + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O

Application of Fertilizer

Plantmate organic fertilizer (POF) was bought from Barangay Mabagun, Hindang, Leyte, Philippines. The specified amount of organic fertilizer was manually incorporated into the soil in each treatment plot, five days before transplanting (Richfund International Co., Ltd., 2015). However, knowing the nutrient composition of POF was obtained from the analysis conducted by Njomo, 2018 while for Prime EC was also obtained as indicated in the label of said product. For treatment plots applied with Prime EC, 4 ml of Prime EC was mixed with one liter of water and sprayed to the crop at 15, 45 and 75 days after transplanting (DAT). For T1, treatment application of complete fertilizer (14-14-14) was done ten days after transplanting and urea (46-0-0) was topdressed at panicle initiation (PI). The actual amount of fertilizers applied is shown in Table 1. PI was the stage when actual panicle or head began to form at the base of the shoot or stem, just above the soil surface. Since PI stage could not be seen by the naked eye, samples were

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collected and dissected following this method: 1) the main stem was selected from the center of each plant, 2) then, the roots were cut just above the root ball, 3) the stem was sliced lengthwise with a sharp knife and lastly, 4) the panicle which appeared as a whitish furry tip of 1 to 3 mm long was identified using a magnifying glass.

Table 1. Amount of commercial organic and inorganic fertilizers applied in kg/10 m^2 plot

Treatment	Method of Basal		Application Top dress	Foliar
	POF (kg)	Complete (14-14-14) (kg)	Urea (46-0-0) (kg)	Prime EC (ml)
T_0 - No fertilizer application (control)	-	-	-	-
T_1 -120-60-60 kg ha^{-1} N, P_2O_5, K_2O (inorganic fertilizer)	-	0.428	0.130	-
T_2 -10 bags ha^{-1} Plantmate Organic Fertilizer (POF)	0.50	-	-	-
T_3 -10 bags ha^{-1} POF + 4 liters ha^{-1} Prime EC (Inorganic fertilizer)	0.50	-	-	4
T_4 -10 bags ha^{-1} POF + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O	0.50	0.214	0.065	-
T_5 -5 bags ha^{-1} POF + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O	0.25	0.214	0.065	-

Moisture Content Determination

The moisture content of Plantmate organic fertilizer (POF) was determined by oven drying three 100 g sample at 70 °C until constant weight of the sample was obtained.

Seedbed Preparation

Wet seedbed with an area of 10 m^2 (5 m x 2 m) with drainage canal around the bed was constructed in a separate area of the experiment. One kilogram of NSIC Rc308 rice seeds was soaked in water for 24 hours and incubated for 48 hours before sowing in the seedbed (Baoy and Bañoc, 2017). Care and management of the seedlings such as irrigation, fertilization and pest management were employed until seedlings were pulled out for transplanting.

Transplanting

Fifteen days after sowing, the seedlings were transplanted at the rate of 1-2 seedlings per hill^{-1} with a plant spacing of 20 cm x 20 cm. Missing hills were replanted seven days after transplanting (DAT).

Pest Management

Golden apple snails (GAS) were controlled by hand picking and intermittent irrigation at weekly interval was done. Rotary weeding was employed 15 days after transplanting in all treatment plots. After rotary weeding, hand weeding followed to remove the weeds around each hill. During the vegetative and heading stages, Lannate (Cypermethrine) was applied to control leafhoppers, rice bugs, and other insect pests at the rate of 3 tbsp. in 16 liters^{-1} of water. Rodents were controlled using traps while scarecrows were established as preventive measures for maya (*Lonchura malaca*) and gorion (*Passer montanos*) bird infestations.

Water Management

Three days after transplanting, the area was irrigated at a depth of 2.5 cm. A week after, water gradually increased up to a depth of 5 cm depending on the growth of rice plants. Water was reduced to a depth of about 1 cm during the weeding operation. Two weeks before maturity, the area was drained to improve the physical condition of the field and to facilitate harvesting.

Harvesting and Processing

Harvesting was done when 85% of the grains in the panicles were ripened (Baoy and Bañoc, 2017). This was manifested when grains became firm and straw-colored. The plants were cut at the base using a sharp sickle and within the harvestable area that contained six inners rows (5.52 m^2) excluding the two border rows and one end hill in each row in every treatment plot. Panicles in each treatment plot were threshed, sundried for three days and winnowed before data gathering.

Data Gathered

Agronomic Characteristics

The following agronomic characteristics were noted:

1. Days from sowing to heading – This was determined by counting the number of days from sowing up to the time when approximately 50 % of the panicles in each treatment plot exerted from the flag leaf sheath.
2. Days from sowing to maturity – This was determined by counting the number of days from sowing up to 85 % of the grains in each panicle reached maturity in each treatment plot.
3. Plant height (cm) at harvest – This was collected by measuring 10 sample hills within the inner rows from the ground level up to the tip of the longest leaf three days before harvest.
4. Leaf area index (LAI) – This was obtained at heading stage following this procedure:
    a. Five hills were selected randomly from each treatment plot and the identified hills were surrounded by living hills.

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b. The number of tillers was counted for each hill.
c. The middle tiller of each sample hill

was located.
d. The length and broadest width of all leaves of the middle tiller of each sample hill were measured using a ruler.
e. The area of each leaf in the middle tiller was computed following the formula:

$$LA= L \times W \times CF$$

where:

L = length of leaf (cm)

W = width of leaf measured at the broadest part (cm)

CF = correction factor which is equal to 0.75 (Yoshida, 1981)

f. The leaf area of all leaves was added to get the total area of the middle tiller.
g. The total leaf area hill^{-1} was computed following the formula:
Leaf area hill^{-1} = total leaf area of middle tiller x total number of tillers
h. The leaf area index (LAI) was computed using the formula:

$$LAI= \frac{\text{sum of all leaf area hill}^{-1}\text{ (5 samples, cm}^2)}{\text{ground area (5 hills , 2,000 cm}^2)}$$

5. Fresh straw yield (t ha^{-1}) – All harvestable plants in each treatment plot excluding the border rows and end hills were cut at the ground level and weighed without panicles. The weight was converted into hectare-1 basis using the formula:

$$\text{Straw yield (t ha}^{-1}) = \frac{\text{straw yield (kg)}}{\text{Harvestable area (5.52 m}^2)} \times \frac{10{,}000\text{ m}^2\text{ ha}^{-1}}{1{,}000\text{ kg t}^{-1}}$$

6. Number of nodal roots hill^{-1} – This was determined by counting all the nodal roots (adventitious roots that formed rings from stem tissues around a node) from three sample hills treatment plot-1 at heading stage. The samples were taken through destructive sampling by uprooting the plants and washing off any loose soil in rows between the border and harvestable rows.
7. Root dry weight plant^{-1} (g) – This was done by weighing the oven dried roots of the three sample plants after cleaning the root samples at heading stage. The said samples were oven dried at 70 °C for 72 hours before weighing.
8. Shoot dry weight plant^{-1} (g) – This was done by weighing the oven dried shoots of the three sample plants at heading stage. The said samples were oven dried at 70 °C for 72 hours before weighing.
9. Root shoot ratio plant^{-1} – This was done by dividing the root dry weight over the shoot dry weight of the three sample plants treatment plot^{-1}. High root shoot ratio indicated that it could compete more effectively for soil nutrients and could intercept more light while the opposite was true for low root shoot ratio.

Yield and Yield Components

1. Number of productive tillers hill^{-1} – This was gathered by counting the number of tillers of five sample hills that developed panicles in each treatment plot at maturity.
2. Number of filled grains panicle^{-1} – This was done by counting the number of filled grains of five sample panicles obtained from each treatment plot at maturity.
3. Percentage of filled grains – This was done by dividing the number of filled grains by the total number of grains in each panicle.
4. Panicle length (cm) – This was determined by measuring the length of five sample panicles plot^{-1} from the base to the tip of the panicle. The average length was computed by dividing the total length by the number of sample panicles.
5. Panicle weight (g) – This was determined by weighing the panicles obtained from five sample hills treatment plot^{-1} and the average was taken.
6. Weight (g) of 1,000 grains – This was determined by weighing 1,000 grains taken randomly from each treatment plot. The grains were sundried to attain approximately 14% moisture content before weighing.
7. Grain yield (tha^{-1}) – All the plants within the harvestable area in each treatment plot were harvested and threshed. The grains were cleaned and sundried for three days before weighing. The weight plot^{-1} was converted into t ha-1 basis using the formula:

$$\text{Grain yield (tha}^{-1}) = \frac{\text{Plot yield (kg)}}{\text{Harvestable area (5.52 m}^2)} \times \frac{10{,}000\text{ m}^2\text{ ha}^{-1}}{1000\text{ kg t}^{-1}}$$

Harvest Index

Harvest index (HI) is the ratio of the weight of filled grains to the weight of the straw, chaff, and filled grains under dry weight basis. HI indicates the plant's efficiency to convert the absorbed nutrients and the products of photosynthesis into economic yield. High harvest index means that there is a high grain yield produced in proportion to the straw yield. On the other hand, low harvest index means there is less grain yield produced in proportion to the straw yield obtained.

Three sample hills were used in gathering HI. These were gathered ahead of harvesting. The chaff and straws were separated from the grains by placing them in separate bags. These were oven dried at 70 °C for three days. HI was obtained by using the formula:

$$HI = \frac{\text{Economic yield}}{\text{Biological Yield}} = \frac{\text{Dry weight of grains (g)(3 sample hills))}}{\text{Dry weights (g) of grains + straw (g)(3 sample hills) + chaff}}$$

Cost and Return Analysis

The cost of production was determined by recording all the expenses incurred throughout the conduct of the study from land preparation, harvesting and postharvest handling operations. This also included cost of chemicals, labor and other materials used. The gross income was determined by multiplying the yield

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of each treatment plot by the current price of *palay* in kilogram basis. All expenses were summed up for the determination of the most economical treatment that would give the highest net return using the formula:

Net Profit = Gross Income - Total Cost of Production

Meteorological Data

Total weekly rainfall (mm), average daily minimum and maximum temperatures (°C) and relative humidity (%) throughout the conduct of the study were taken from the records of the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) Station, Visayas State University, Visca, Baybay City, Leyte, Philippines.

Statistical Analysis

Data was analyzed by ANOVA using Statistical Tool for Agricultural Research (STAR). Comparison of means was done using the Honestly Significant Difference (HSD) using 5% level of significance.

3 RESULTS AND DISCUSSION

Soil Characteristics

Initial soil analysis indicated that the experimental area with alluvial clay loam type of soil was moderately acidic (pH-5.66), with very low amount of organic carbon (1.47%), medium amount of total N (0.25%), high amount in both available P (15.24 mg/kg) and exchangeable K (0.93 me/100g) based on Landon, 1991, Appendix Table 1.

For final soil analysis, result showed that the pH, available P along with exchangeable K decreased. Although application of combined organic and inorganic fertilizers relatively increased organic carbon content and total N, similar result was noted in control plots as reflected in Table 2. The slight increase in soil organic carbon after harvest of rice could be accounted to the management practice like organic fertilizer application (Chan, 2008) and might be due to the application of POF since this fertilizer material contains adequate amount of essential nutrients like N (2%), P (3%) and K (3%). Increase in total N could be due to the decayed plant parts and applied organic fertilizer (POF) which contributed to the additional amount of organic materials in the soil. However, the decrease in the amount of available P and exchangeable K might be attributed to the utilization of the aforesaid nutrients by rice plants while the decrease of soil pH could be attributed to leaching of basic cations and run-off due to irrigation.

Agronomic Characteristics

Statistical analysis revealed that all agronomic characteristics of lowland rice were significantly affected by the treatments. Results also revealed that rice plants fertilized with ten bags ha^{-1} POF + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O (half of the recommended rate) (T_4) and five bags ha^{-1} POF + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O (half of the recommended rate) (T_5) extended significantly the vegetative growth of plants and had a comparable duration with those plants fertilized with 120-60-60 kg ha^{-1} N, P_2O_5, K_2O (T_1). Plants applied with commercial organic fertilizer (T_2), ten bags ha^{-1} POF + Prime EC 4 liters ha^{-1} (T_3) and unfertilized control (T_0) had significantly shorter vegetative growth by heading and maturing the earliest (Table 3a–3b).

Treatment plants applied with 10 bag ha^{-1} commercial organic fertilizers (T_2) and 10 bags ha^{-1} POF + Prime EC four liters ha^{-1} (T_3) as well as control plants (T_0) matured the earliest as compared to all other treatments. These marked variations were attributed to the availability of nutrients in the inorganically-treated plants due to inorganic fertilizer application. Sufficient nutrient availability prolonged the vegetative growth of rice by producing more productive tillers and greener foliage. On the other hand, insufficient nutrient also resulted to its faster utilization or consumption thus, enhancing maturity. This result conformed with the findings of Balana (2003) who emphasized that the lower the amount of fertilizer applied, the faster it would be utilized by the plant leading to early and faster growth and development.

Among the treated plots, rice plants fertilized with five bags ha^{-1} POF + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O (T_5) grew significantly taller (123.43 cm) than the plants applied with ten bags ha^{-1} POF (T_2), ten bags ha^{-1} POF + Prime EC four liters ha^{-1} (T_3) and unfertilized control plants (T_0). However, this was not significantly different with those plants applied with the recommended rate of inorganic fertilizer 120-60-60 kg ha^{-1} N, P_2O_5, K_2O (T_1) and also to those the plants applied with ten bags ha^{-1} POF + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O (T_4). Result of the study showed that application of half of the recommended rate of inorganic fertilizer to fertilized plants in T_4 and T_5 promoted the growth and development of their vegetative parts through faster growth of main tillers. This finding construed with the result of Queliste (2004) stipulated that application of inorganic fertilizer particularly nitrogen significantly achieved taller plant height when compared to unfertilized plants. This result was also supported by the claim of Rahman et al., (2014) who concluded that application of N fertilizer in adequate amount is vital for plant growth and development that apparently leads to higher grain yield of wheat.

Leaf area index (LAI) was significantly affected by the application of POF and inorganic fertilizers. Rice plants applied with five bags ha^{-1} POF + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O (T_5) attained high LAI of 3.93 but comparable to plots treated with 120-60-60 kg ha^{-1} N, P_2O_5, K_2O (T_1). This result strongly suggests that combined application of both half of the recommended rate of POF and inorganic fertilizer can suffice the need of the plant's growth and development particularly production of longer and broader leaves. This result conformed with findings of Baoy and Bañoc (2017) that application of half of the recommended rate OF Plus organic fertilizer combined with 60-30-30 kg ha^{-1} N, P_2O_5, K_2O inorganic fertilizer achieved significantly greater LAI than those plants applied with recommended rate of organic fertilizer and also those

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plants that did not received fertilizer (control). In terms of straw yield, plants applied with 120-60-60 kg ha^{-1} N, P_2O_5, K_2O (T_1) produced significantly the heaviest straw yield of 25.73 tha^{-1} followed by plants applied with 10 and 5 tha^{-1} POF + both applied with half of the recommended rate of inorganic fertilizers than the other treatments (Table 3a). Statistical analysis revealed that combined application of POF even at half of the recommendation accompanied with half of the recommended rate of inorganic fertilizer can markedly enhanced productivity of aboveground parts leading to an increase in straw yield. The significant increase in straw yield was contributed by the increased plant height and leaf area indices. This result was supported by the claim of Patolilic (1988) who said that increased plant height and higher LAI result to a corresponding increase in dry matter of the vegetative parts thus, increasing herbage yield. Relative to root system development, the number of nodal roots was significantly affected by the treatments (Table 3b). Nodal roots of rice plants that received ten bags ha^{-1} POF (T_2) obtained higher number of nodal roots of 383.67 cm. This was comparable to all other treatments except for unfertilized control (T_0). The result supported the report that Plantmate organic fertilizer provides good soil tilth that encourages more vigorous and more profuse growth of root hairs (www.plantmateorganics.com). Result of the study indicated that limited root growth and development of unfertilized plants was attributed to the limitation of translocated assimilates into the roots (Bidwell, 1974). Thus, result conformed to the findings of Bañoc et al., (2000) that more number of nodal roots with longer root axis length were strong manifestations on the ability of fertilized plants to improve its root morphology and physiology in response to the changing in soil environment. Plants applied with ten bags ha^{-1} POF + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O (T_4) achieved significantly higher root dry weight of 2.96 g than those plants applied with five bags ha^{-1} POF + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O (T_5) and also in unfertilized control. Result showed that reduction on the application of inorganic fertilizer to half of the recommended rate but with combined application of POF may provide favorable growth and development of the roots system, which might developed longer and/or bigger roots. This result proved that higher level of fertilization produced heavier root dry weight which could be attributed to a more favorable translocation of assimilates to the roots than that of the shoot for better root growth and development. In case of shoot dry weight, plants applied with POF alone or in combination with inorganic fertilizer obtained considerably lower than those applied with 120-60-60 kg ha^{-1} N, P_2O_5, K_2O (T_1). The least shoot dry weight was noted in unfertilized control. This simply showed that the increase in shoot dry weight could be due to high level of applied inorganic fertilizer that promoted production of more tillers and broader leaves.

In effect, the root: shoot ratio revealed that application of POF at ten bags ha^{-1} achieved significantly higher ratio especially in plants with combined inorganic fertilizers at 60-30-30 kg ha^{-1} N, P_2O_5, K_2O. Plants applied with pure inorganic fertilizer 120-60-60 kg ha_{-1} N, P_2O_5, K_2O (T_1) and those applied with only five bags ha^{-1} POF + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O (T_5) obtained relatively lower root: shoot ratio. This suggests that those treatments with high root: shoot ratio could compete more effectively in taking up soil nutrients and water. On the other hand, treatments T_1 and T_5 achieved lower root: shoot ratio and it could have intercepted more light because of its higher leaf area indices (Table 3a).

Table 2. Soil chemical properties before planting and after harvest of lowland rice (NSIC Rc308) as influenced by application of commercial organic and inorganic fertilizers

Treatment	Soil pH (1:1) soil-water ratio	Organic Carbon (%)	Total N (%)	Available P (mg kg^{-1})	Exchangeable K ($me100g^{-1}$)
Initial analysis	5.66	1.47	0.25	15.24	0.93
Final analysis					
T_0 - No fertilizer application (control)	5.36	2.69	0.31	10.51	0.37
T_1 -120-60-60 kg ha^{-1} N, P_2O_5, K_2O (inorganic fertilizer)	5.19	2.69	0.27	10.83	0.40
T_2 -10 bags ha^{-1} Plantmate Organic Fertilizer (POF)	5.31	2.60	0.28	12.91	0.33
T_3 -10 bags ha^{-1} POF + 4 liters ha^{-1} Prime EC (Inorganic fertilizer)	5.23	2.60	0.26	11.47	0.39
T_4 -10 bags ha^{-1} POF + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O	5.26	2.96	0.31	15.07	0.26
T_5 -5 bags ha^{-1} POF + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O	5.14	3.12	0.27	13.21	0.30

Yield, Yield Components and Harvest Index

Statistical analysis revealed that all yield and yield components and harvest index were not significantly affected by the different treatments except for the grain yield (t ha^{-1}). Grain yield (t ha^{-1}) was remarkably influenced by the combined application of organic and inorganic fertilizers. Plants applied with fertilizers

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regardless of types (organic or inorganic) and combinations (T_1 & T_5) significantly obtained higher grain yield than the unfertilized plants (T_0) as reflected in Table 4b.

This result could be explained by the higher LAI and more nodal roots attained by fertilized plants which correspondingly achieved higher grain yield. High LAI might increase photosynthetic activity of plants that led to abundant production and translocation of photosynthates leading for the production of heavier grains (Yoshida, 1972). This construed with the findings of Lucero (1995) who mentioned that application of fertilizer enhanced rapid development of more productive tillers, larger panicle length, heavier panicle weight and higher grain yield. In this study, these yield components were more or less the same, irrespective of the treatments.

Mahmud et al., (2002) mentioned that application

Table 3a. Agronomic characteristics of lowland rice (NSIC Rc308) as influenced by application of commercial organic and inorganic fertilizers

Treatment	Number of days from sowing to		Plant height (cm)	Leaf area index	Fresh straw yield (t ha^{-1})
	Heading	Maturity			
T_0 - No fertilizer application (control)	73.33^{c}	100.33^{e}	110.13^{c}	2.47^{b}	15.27^{b}
T_1 -120-60-60 kg ha^{-1} N, P_2O_5, K_2O (inorganic fertilizer)	77.00^{a}	104.33^{a}	124.97^{a}	5.80^{a}	25.73^{a}
T_2 -10 bags ha^{-1} Plantmate Organic Fertilizer (POF)	73.67^{c}	101.33^{de}	113.77^{bc}	3.12^{b}	15.16^{b}
T_3 -10 bags ha^{-1} POF + 4 liters ha^{-1} Prime EC (Inorganic fertilizer)	74.67^{bc}	101.67^{cd}	111.77^{bc}	2.87^{b}	14.01^{b}
T_4 -10 bags ha^{-1} POF + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O	76.33^{a}	103.00^{b}	120.43^{ab}	3.10^{b}	20.23^{ab}
T_5 -5 bags ha^{-1} POF + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O	76.00^{ab}	102.67^{bc}	123.43^{a}	3.93^{ab}	19.08^{ab}
C.V (%)	0.64	0.43	2.72	26.35	13.79

Treatments means within the same column followed by a common letter are not significantly different from each other at 5% level, HSD

Table 3b. Agronomic characteristics of lowland rice (NSIC Rc308) as influenced by application of commercial organic and inorganic fertilizers

Treatment	Number of nodal roots $plant^{-1}$	Root dry weight $plant^{-1}$ (g)	Shoot dry weight $plant^{-1}$ (g)	Root shoot ratio (g)
T_0 - No fertilizer application (control)	295.33^{b}	1.77^{b}	20.87^{c}	0.09^{ab}
T_1 -120-60-60 kg ha^{-1} N, P_2O_5, K_2O (inorganic fertilizer)	399.67^{a}	2.64^{ab}	34.43^{a}	0.08^{b}
T_2 -10 bags ha^{-1} Plantmate Organic Fertilizer (POF)	383.67^{a}	2.09^{ab}	22.22^{bc}	0.09^{ab}
T_3 -10 bags ha^{-1} POF + 4 liters ha^{-1} Prime EC (Inorganic fertilizer)	360.67^{a}	2.21^{ab}	25.71^{b}	0.08^{ab}
T_4 -10 bags ha^{-1} POF + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O	377.67^{a}	2.96^{a}	25.14^{bc}	0.12^{a}
T_5 -5 bags ha^{-1} POF + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O	375.33^{a}	1.86^{b}	25.81^{b}	0.07^{b}
C.V (%)	4.29	14.68	6.60	12.88

Treatments means within the same column followed by a common letter are not significantly different from each other at 5% level, HSD

Table 4a. Yield and yield components of lowland rice (NSIC Rc308) as influenced by application of commercial organic and inorganic fertilizers

Treatment	No. of productive tillers $plant^{-1}$	No. of filled grains $panicle^{-1}$	Percent filled grains (%)	Panicle length (cm)
T_0 - No fertilizer application (control)	12.53	77.73	59.05	24.40
T_1 -120-60-60 kg ha^{-1} N, P_2O_5, K_2O (inorganic fertilizer)	16.80	106.80	66.79	25.97
T_2 -10 bags ha^{-1} Plantmate Organic Fertilizer (POF)	13.87	103.13	66.30	24.83
T_3 -10 bags ha^{-1} POF + 4 liters ha^{-1} Prime EC (Inorganic fertilizer)	13.53	88.40	65.15	24.76
T_4 -10 bags ha^{-1} POF + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O	14.47	109.40	66.78	25.57
T_5 -5 bags ha^{-1} POF + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O	14.67	92.13	60.16	25.46
C.V (%)	13.47	15.94	10.77	3.81

Treatments means within the same column followed by a common letter are not significantly different from each other at 5% level, HSD

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Table 4b. Yield and yield components of lowland rice (NSIC Rc308) as influenced by application of commercial organic and inorganic fertilizers

Treatment	Panicle weight (g)	Weight of 1,000 grains (g)	Grain yield (t ha^{-1})	Harvest index
T_0 - No fertilizer application (control)	2.66	22.67	1.35b	0.36
T_1 -120-60-60 kg ha^{-1} N, P_2O_5, K_2O (inorganic fertilizer)	3.27	23.23	2.63a	0.43
T_2 -10 bags ha^{-1} Plantmate Organic Fertilizer (POF)	3.15	22.80	2.54a	0.40
T_3 -10 bags ha^{-1} POF + 4 liters ha^{-1} Prime EC (Inorganic fertilizer)	2.66	22.70	3.03a	0.43
T_4 -10 bags ha^{-1} POF + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O	3.32	23.50	2.86a	0.38
T_5 -5 bags ha^{-1} POF + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O	3.02	22.63	2.66a	0.43
C.V (%)	13.90	3.24	16.94	10.65

Treatments means within the same column followed by a common letter are not significantly different from each other at 5% level, HSD

Table 5. Cost and return of lowland rice (NSIC Rc308) as influenced by application of commercial organic and inorganic fertilizers

Treatment	Grain Yield (t ha^{-1})	Gross Income (PhP)	Production Cost (PhP)	Net Income (PhP)
T_0 - No fertilizer application (control)	1.35	32,200.00	18,931.00	13,269.00
T_1 -120-60-60 kg ha^{-1} N, P_2O_5, K_2O (inorganic fertilizer)	2.63	52,600.00	36,338.00	16,262.00
T_2 -10 bags ha^{-1} Plantmate Organic Fertilizer (POF)	2.54	50,800.00	30,446.00	20,354.00
T_3 -10 bags ha^{-1} POF + 4 liters ha^{-1} Prime EC (Inorganic fertilizer)	3.03	60,600.00	35,857.00	24,743.00
T_4 -10 bags ha^{-1} POF + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O	2.86	57,200.00	40,030.00	17,170.00
T_5 -5 bags ha^{-1} POF + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O	2.66	53,200.00	33,670.00	19,530.00

Calculation of gross income is based on the current price of dried palay at PhP 20 kg^{-1}

of both organic and inorganic fertilizers significantly influenced grain yield of rice plants with lowest yield from the unfertilized control. Harvest index was not significantly affected by the applied treatments which showed that they were more or less comparable (Table 4a – 4b).

Cost and return

Result of economic analysis (Table 5) revealed that the highest net income of PhP 24,743.00 was derived from the application of ten bags ha^{-1} POF + Prime EC four liters ha^{-1} (T_3) while the lowest net income of PhP 13,269.00 was from the control plants (T_0). The higher net income derived from T_3 could be due to relatively lower production cost and slightly higher grain yield. Despite the lowest production cost in control plants (T_0), the markedly lower grain yield caused the least net income.

Highest expense of PhP 40,030.00 which was incurred in plots treated with ten bags ha^{-1} POF + 60-30-30 kg ha^{-1} N, P_2O_5, K_2O (T_4), was mainly contributed by the high cost of both organic and inorganic fertilizers.

4 CONCLUSION

The study found that combined applications of commercial organic and inorganic fertilizers significantly affect the number of nodal roots and grain yield of lowland rice than those unfertilized control. The application of POF and Prime EC achieves higher grain yield than the unfertilized control; however, no significant differences among fertilizer-treated plants are noted.

Then, plants applied with POF at ten bags ha^{-1} + Prime EC at four liter ha^{-1} obtain the highest net income of PhP 24,743.00 and this is considered as the recommended nutrient management option relative to lowland rice production.

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