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Growth and Yield Performance of Irrigated Lowland Rice NSIC Rc218 (*Oryza sativa* L.) as Influenced by Water and Fertilizer Applications

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ABSTRACT

For better rice productivity there is a need to address the problems on water shortage and nutrient management. This study was conducted to evaluate the growth and yield performance and the interaction effect between water and fertilizer applications on irrigated lowland rice (NSIC Rc218); to determine the relationships of other plant characters which are contributory to yield; and to assess the cost and return of irrigated lowland rice production ha^{-1} as influenced by water and fertilizer applications.

Two methods of water application were evaluated and results showed that alternate wet and dry methods (AWD) were able to save 19.02% of the total water received by the rice plants compared to continuous flooded condition. Grain yield of irrigated lowland rice (NSIC Rc218) was significantly (p<0.05) increased by 1.84 t ha^{-1} which is higher by 35% when applied with recommended inorganic fertilizer at the rate of 100-60-60 kg N, P_20_5 and K_20 ha^{-1} (T_2) than that of unfertilized plants (T_1).

Correlation analysis showed that grain yield is positively correlated to the number of productive tillers panicle^{-1}, panicle length (cm), % filled spikelet panicle^{-1}, weight of 1000 grains (g) and LAI but not on the number of spikelets panicle-^{1}. Plants applied with 100-60-60 kg N, P_20_5 and K_20 ha^{-1} (T_2) and those applied with 75% RRIF + 25% RRVC (T_4) generated the highest net income of PhP 66,915.00 ha^{-1} and PhP 60,440.00 ha^{-1} respectively, than unfertilized plants of PhP 40,375.00 ha^{-1}.

Keywords: Flooded, AWD, water and fertilizer applications, performance and fertilizer

INTRODUCTION

Rice (*Oryza zativa* L.) is one of the most important staple foods and sources of livelihood among rice farmers not only in Eastern Visayas but also in some rice growing areas in Southeast Asia IRRI (2011). Rice not only fulfills the nutritional needs of human beings but also possesses

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several medicinal properties and therapeutic values. The Food and Agriculture Organization (FAO) reported that the world rice consumption in 2013-2014 was around 475.5 million tons, but it is expected to increase to 489.4 million tons in 2015-2016 (Rice Global Production, 2015).

Irrigated lowland rice like NSIC Rc218 developed by PhilRice is considered special rice because it has high sensory preference and acceptability as it is tender and tastier than the other common rice varieties (PhilRice, 2013). However, its yield potential cannot cope with the present demand, so there is a need to find ways to increase its production. Among the numerous ways to increase production are to improve the cultural management practices such as the fertilizer and water applications. To address this problem, new methods of irrigation are urgently needed to save water and sustain good yield of rice (Tuong and Bouman, 2002). A number of studies have shown that intermittent flooding to keep the soil saturated provides better water-use efficiency (Ratilla and Cagasan, 2011). The study of Hamora and Agustin (2014) revealed that the continuous use of organic and inorganic sources of nutrients had positive effects on the growth and yield performance of lowland rice. However, there is still lack of information on how the kind of fertilizer (organic, inorganic or a combination of the two) will influence the growth and yield of a particular rice/variety under different water applications (flooded and alternate wetting and drying (AWD).

Thus, this study was conducted to evaluate the growth and yield performance of irrigated lowland rice (NSIC Rc218) as influenced by water and fertilizer applications; to determine the interactions between water and fertilizer applications on all parameters gathered; to determine the relationships of other plant characters which are contributory to yield; and asses the cost and return analysis of irrigated lowland rice production ha^{-1} as influenced by water and fertilizer applications.

MATERIALS AND METHODS

The experiment was laid out in split plot arranged in a Randomized Complete Block Design (RCBD) with three replications. Water applications (WA_1- Flooded and WA_2- AWD) were designated as the main plot, while fertilizer applications (T_1- No fertilizer application as control, T_2 -100-60-60 kg N, $P_2 0_5$ and $K_2 0$ ha^{-1}Recommended Rate of Inorganic Fertilizer (RRIF), T_3-Vermicast at 10 t ha^{-1} Recommended Rate of Vermicast (RRVC), T_4- 75% RRIF + 25% RRVC, T_5 – 50% RRIF + 50% RRVC and T_6 – 25% RRIF + 75% RRVC) were designated as the subplot.

Before transplanting the rice seedlings, ten (10) soil samples were collected at random from the experimental area at a depth of 0-20 cm. After harvest, five soil samples were also collected from each treatment plot. These were composited, air-dried, pulverized and sieved using a 2-mm wire mesh. Soil pH was measured potentiometrically in soil/solution suspensions of 1:2:5 H_2O. The organic carbon content was determined using Walkley-Black method, while the available P was determined using Bray No. 2 method. Exchangeable K, particle size distribution (analyzed using the hydrometer method), and water holding capacity were all determined following the methods described in a handbook on 'Standard Methods of Analysis for Soil, Plant Tissue, Water and Fertilizer' prepared by PCARRD (1980).

Vermicast organic fertilizer and inorganic fertilizer were used in this study. The vermicast was obtained from Organic Diversified Integrated Farming System (ODIFS), VSU, Baybay City, Leyte. Full amount of vermicast in treatments 3 to 6 (T_3 - T_6) were applied five days before planting. Whole amount of P_20_5, K_20 and half of N fertilizers required were applied in all treatment plots immediately before planting by broadcasting and incorporating it into the soil. The remaining half of N was top-dressed forty (40) days after transplanting. The different water applications were applied seven days after transplanting. For WM_1 (Flooded) the area was continuously flooded at a depth of two to four cm up to maximum tillering stage. This was increased to a depth of five to seven cm until reproductive stage. Two weeks before harvest, the whole area was drained to facilitate harvesting operation.

For WM_2 (AWD), the area was irrigated when the field starts to dry up and partially crack or the rice plants showed early sign of wilting as manifested by curling of the young leaves. This was observed during the hottest hour of the day. The field was irrigated right away because rice plants experienced water stress once signs of wilting were observed. Irrigation was done by allowing the entry of water just enough to keep the soil moist. Irrigation water from the river banks served as the source of water in all the rice fields in the area. This was done by maintaining the flow/current of water from the main canal before application to the experimental plots. Drainage canal was constructed to drain the excess water from designated plots during rainy days. Plastic lining around the treatment plots was installed along the levees to control water seepage and contamination among treatment plots.

All the recommended cultural management practices for rice production were strictly followed from land preparation up to harvesting and processing.

Data Gathered

The parameters evaluated for this study were the total amount of water received by the rice plant (m^3ha-^1) and the agronomic characteristics such as the number of days from transplanting to heading and maturity; plant height (cm) at harvest; fresh straw yield (t ha^{-1}) and leaf area index (LAI). For the yield and yield component characteristics, the following parameters were measured such as the number of productive tillers $hill^{-1}$, number of filled grains per panicle, number of unfilled grains per panicle, weight of 1,000 grains (g) and total grain yield (t ha^{-1}). Harvest index was calculated as the ratio of the economic yield and biological yield while initial and final soil analyses and production cost and return were also computed.

RESULTS AND DISCUSSION

Agronomic Characteristics

The agronomic characteristics of irrigated lowland rice (NSIC Rc218) as influenced by water and fertilizer applications are presented in Table 1.

All agronomic characteristics were significantly affected by the water application except on straw weight. Plants grown under flooded condition significantly (p<0.05) matured late, grew taller with broader leaf area, but low number of tillers $hill^{-1}$ than those plants grown in AWD condition. The significant variation observed in the growth and maturity of the rice plant can be attributed to several environmental factors such as soil, nutrients, water and agro-climatic conditions. This indicates that rice plants perform better under continuous flooding which resulted in increased plant height and leaf area index. Flooded condition enhanced softness of the soil that provided good physicochemical changes favorable for nutrient absorption by the rice plants.

Table 1. Growth characteristics of NSIC Rc218 as influenced by water and fertilizer applications, DS 2014, Baybay City, Leyte

Treatments	Number of days to maturity	Plant height (cm)	Leaf area index	Number of tillers $hill^{-1}$	Straw weight (t ha^{-1})
Water Applications					
WM_1 = Flooded	111.70^a	109.65^a	3.74^a	15.12^b	6.47
WM_2 = AWD	110.00^b	103.73^b	3.15^b	16.52^a	6.08
HSD 0.05	**	**	**	*	ns
Fertilizer Application					
T_1 = No fertilizer (Control)	109.50^c	95.48^e	2.07^d	13.73^{cd}	4.91^c
T_2= 100-60-60 kg N, P_20_5, and K_20 ha^{-1} (RRIF)	112.50^a	117.60^a	5.12^a	20.00^a	7.88^a
T_3= Vermicast 10 t ha^{-1} (RRVC)	109.50^c	99.40d^e	2.37^d	12.46^d	4.59^c
T_4= 75% RRIF + 25% RRVC	112.50^a	114.20^{ab}	4.28^{ab}	17.70^{ab}	7.47^{ab}
T_5= 50% RRIF + 50% RRVC	110.50^b	109.80^{bc}	3.72^{bc}	16.70^{bc}	6.53^{bc}
T_6= 25% RRIF + 75% RRVC	110.50^b	103.70^{dc}	3.10^{dc}	14.30^{cd}	5.26^c
HSD 0.05	**	**	*	**	**

Means with the same letter in a columns and rows are not significantly different at 5% level, HSD.

Moreover, Bouman *et al.* (2007) mentioned that flooded condition also offers a kind of temperature control for the rice crop. On hot days the water-filled fields keep the rice plants cool, and warm them on cool nights. Flooded condition helps in preventing excessive salt accumulation and soil depletion thus enhances nutrient uptake and absorption by plants resulting in taller and more vigorous plants.

On the other hand, the number of tillers per hill was significantly (p<0.05) higher under AWD than under flooded condition. Aslam and Horinkova (2002) found that the better gas exchange between soil and air leads to better aeration in soil medium under AWD condition that consequently resulted to a more favorable development of young shoots and higher number of tillers produced per hill. Moreover, according to Aslam *et al.* (2002), drying the field can reduce the toxicity of organic and inorganic toxins that accumulate from the decomposition of organic materials at the beginning of the cropping season, thus leading to favorable development of young shoots and to more tillers.

Fertilizer application significantly affected all the agronomic characteristics of irrigated lowland rice (NSIC Rc218) such as the number of days to maturity, plant height, straw yield ha^{-1}, leaf area index and number of tillers $hill^{-1}$. Rice plants applied with inorganic fertilizer at the rate of 100-60-60 kg N, P_20_5 and K_20 ha^{-1} and those with 75% RRIF + 25% RRIF grew vigorously with broader leaf area, taller plants and produce more tillers $hill^{-1}$ resulting in heavy straw weight. They matured later than those plants applied with low rates of RRIF at 25% and 50%, vermicast at 10 t ha^{-1} and plants without fertilization. Increasing the application of inorganic fertilizer delayed the maturity of rice plants but caused taller plants compared to those applied with vermicast and without fertilizer. Moreover, treatments with higher amount of inorganic fertilizer showed positive response to agronomic parameters such as plant height, leaf area index, number of tiller $hill^{-1}$ and straw weight t ha^{-1}. These results correlated to the findings of Hamora and Agustin (2014) which showed that most of the agronomic characteristics of rice were significantly affected by inorganic fertilizer hence, resulted in taller plants with broader leaf area index, more number of tiller $hill^{-1}$ and heavier straw weight. According to Bouman *et al.* (2007) plant height is increased significantly due to nitrogen application which enhances physiological processes such as cell division and cell elongation. However, Haby *et al.* (2012) reported that high amount of N promotes development of above ground parts of the plant caused by high assimilates formation during photosynthates that leads to increased plant heights but delayed flowering as well as maturity of the rice plant.

Yield, Yield Components and Harvest Index

The yield and yield components as well as harvest index of irrigated lowland rice (NSIC Rc218) as influenced by water and fertilizer applications are presented in Table 2. Among the rice yield parameters gathered, only panicle length (cm) and number of filled grains $panicle^{-1}$ were significantly (p<0.05) affected by water application. However, under fertilizer treatments yield and other yield components were significantly affected except harvest index.

It was noted that rice plants under flooded conditions developed longer panicles with more number of filled spikelet than plants subjected to AWD condition. This result was attributed to the presence of enough moisture that enhanced nutrient absorption by the rice plants resulting in vigorous growth as evidenced by an increased plant height and leaf area index (Table 1). This study supports the findings of Maclean *et al.* (2002) showing that development of higher number of filled grains per panicle with lower percent spikelet sterility when enough water was made available specifically during panicle initiation stage. However, Ratilla and Cagasan (2011) observed that conventional irrigation led to the production of longer panicles and more filled grains per panicle but did not cause significant (p<0.05) increase in yield of irrigated lowland rice. This result confirmed the finding of Bouman *et al.* (2007) that in rice production it does not need more water or total plant submergence throughout the growing period to have good crop yield.

On the other hand, irrigated lowland rice (NSIC Rc218) responded significantly (p<0.05) in all yield components to different fertilizer applications. Treatments applied with RRIF at the rate of 100-60-60 kg N, P_20_5 and K_20 ha^{-1} significantly produced more productive tillers plant^{-1}, longer panicle length, more number and high percent filled spikelets as well as heavier weight of 1000 grains thus resulting in higher total grain yield. However, it was statistically similar to those treatments applied with 75% RRIF + 25% RRVC and 50% RRIF + 50% RRVC. Result further that inorganic fertilizer is a contributory factor to the showed yield component for rice production. Nutrients from pure inorganic fertilizer at the rate of 100-60-60 kg N, P_2O_5 and K_2O ha^{-1}, 75% RRIF + 25% RRVC and 50% RRIF + 50% RRVC provided sufficiently the nutrient requirement of rice plant during grain formation and filling. On the other hand, the lowest yields were noted in treatments applied with vermicast at 10 t ha^{-1} (T_3), 25% RRIF + 75% RRVC (T_6) and unfertilized plants (T_1). These results were due to the slow release and insufficient amount of nutrients from treatments applied with full amount of organic fertilizer vermicast, 25% RRIF + 75% RRVC and plants not applied with fertilizer (T_1). Stoop *et al.* (2002) mentioned that nitrogen requirement for grain development is very significant because during the process of spikelet formation, some of the differentiated spikelets degenerate. Degeneration occurs at the stage of reduction division of pollen mother cells resulting in high sterility thus affecting the development and filling of spikelets causing a low number of filled grains per panicle^{-1}.

Substantial differences were observed on the interaction effect between water and fertilizer applications (Table 3). Plants applied with RRIF and RRVC (T_2-T_6) significantly (p<0.05) obtained heaviest weight of 1000 grains (gms) both in flooded and AWD conditions. A significant lightest 1000 grain weight (gms) was observed from unfertilized treatment plants.

Table 2. Yield, yield components and harvest index of NSIC Rc218 as influenced by water and fertilizer applications, DS 2014, Baybay City, Leyte

Treatments	Productive tillers hill^{-1}	Panicle length (cm)	No. of filled spikelet panicle^{-1}	Percentage filled spikelet panicle^{-1}	Weight of 1,000 grains (g)	Grain yield (tha^{-1})	Harvest index (HI)
Water Application							
WM_1 = Flooded	10.19	25.03^{a}	96.72^{a}	76.66	27.52	4.15	0.37
WM_2 = AWD	9.73	23.46^{b}	76.77^{b}	74.55	27.50	4.33	0.38
HSD 0.05	ns	**	**	ns	ns	ns	ns
Fertilizer Application							
T_1 = No fertilizer (Control)	7.91c	21.83^{c}	72.17^{b}	70.83^{b}	26.73^{b}	3.34^{b}	0.36
T_2= 100-60-60 kg N, P_20_5, and K_20 ha^{-1} (RRIF)	11.73^{a}	26.71^{a}	95.33^{a}	80.17^{a}	29.00^{a}	5.18^{a}	0.34
T_3= Vermicast 10 t ha^{-1} (RRVC)	8.50^{bc}	24.25^{b}	85.66^{b}	73.50^{ab}	29.69^{a}	3.50^{b}	0.39
T_4= 75% RRIF + 25% RRVC	10.90^{a}	25.01^{ab}	89.50^{ab}	79.66^{a}	28.45^{a}	5.03^{a}	0.35
T_5= 50% RRIF + 50% RRVC	10.66^{a}	24.30^{b}	90.50^{ab}	73.00^{ab}	28.05^{a}	4.53^{a}	0.37
T_6= 25% RRIF + 75% RRVC	10.03^{ab}	23.38^{bc}	77.33^{b}	76.50^{ab}	28.16^{a}	3.74^{b}	0.41
HSD 0.05	**	**	**	**	**	**	ns

Means with the same letter in a columns and rows are not significantly different at 5% level, HSD

(T_1) under both flooded and AWD conditions. This result is due to a greater amount of nutrients from inorganic fertilizer associated with high solubility and availability when needed by the rice plants. Similarly, vermicast enhanced uptake of nutrients by plants. Soil available nitrogen increased with increasing levels of vermicast and highest nitrogen uptake was obtained resulting in increased filled spikelets and heavier of 1000 grains. On the other hand, unfertilized plants (T_1) resulted in lightest weight (gms) of 1000 grains regardless of water applications. This result was attributed to the insufficient amount of nutrients particularly phosphorus in soil which is needed for grain-filling formation that greatly affects the grain weight.

Table 3. Weight of 1000 grains (gms) of NSIC Rc218 as influenced by the interaction between water and fertilizer applications, DS 2014, Baybay City, Leyte

Fertilizer Application	Water Application		Mean
	Flooded	AWD	
T_1 = No fertilizer (Control)	26.30^c	27.17^c	26.73^b
T_2= 100-60-60 kg N, P_2O_5, and K_2O ha^{-1} (RRIF)	29.06^a	28.94^a	29.00^a
T_3= Vermicast 10 t ha^{-1} (RRVC)	29.74^a	29.65^a	29.69^a
T_4= 75% RRIF + 25% RRVC	28.37^b	28.53^b	28.45^a
T_5= 50% RRIF + 50% RRVC	28.13^b	27.98^b	28.05^a
T_6= 25% RRIF + 75% RRVC	28.42^b	28.91^b	28.16^a
Mean	27.52	27.50	

Means with the same letter in a column are not significantly different at 5% level, HSD.

Relationships Between Grain Yield and Yield-Contributing Characters

Correlation analysis was done to determine the relationship between the yields of irrigated lowland rice (NSIC Rc218) to different yield contributory parameters. Most of the contributory characters for yield were positively correlated to productivity except on the number of spikelet per panicle (Table 4). Productive tillers were highly correlated to yield while, panicle length, percent filled spikelet, weight of 1000 grains (gms) and leaf area index were significantly correlated to the grain yield. These results indicated that the yield components significantly influenced the improvement and production of total grain yield.

Ebrahim (2014) reported that photosynthates absorbed by rice plants are utilized in the improvement of yield and yield characters of irrigated lowland rice for the production of the total grain yield. On the other hand, no association was noted between number of filled spikelets panicle^{-1} and grain yield t ha^{-1}. This result indicated that number of spikelets per panicle did not increase the total grain yield of NSIC Rc 218.

The above findings corroborate the report of PhilRice (2011) that different levels of nitrogen, phosphorus and potassium indicated a positive relationship with grain yield, relative to the number of productive tillers, number and percent filled spikelet and 1000-grain weight.

Table 4. Correlation analysis between grain yield and yield contributing characters of NSIC Rc 218 as influenced by water and fertilizer applications, DS 2014, Baybay City, Leyte

	Yield ($t\ ha^{-1}$)	No. of Productive Tillers hill-1	Panicle Length (cm)	Number of spikelets panicles^{-1}	% Filled Spikelets panicle^{-1}	1000 grains (gms)	LAI
Yield	1.000						
Productive Tillers hill^{-1}	0.839 **	1.000					
Panicle Length (cm)	0.652*	0.779**	1.000				
No. of Spikelets panicle-1	0.119ns	0.169ns	0.522ns	1.000			
% Filled Spikelets panicle^{-1}	0.614*	0.739**	0.787**	0.345ns	1.000		
Wt. of 1000 grains (gms)	0.856**	0.747**	0.655*	0.185ns	0.464ns	1.000	
LAI	0.859**	0.945**	0.86**	0.324ns	0.767**	0.80**	1.00

r tab0.05 = 0.811
r tab0.01 = 0.917

ns- not significant, ,
*-Significant correlation
**-Highly positive correlation

Soil Chemical Properties

Results of initial soil analysis showed that the soil had a pH of 5.51 with 4.61% OM, 0.24% total N, 1.78% available P and 41.27 mg kg^{-1} exchangeable K (Table 5). These indicated that the soil was strongly acidic with adequate amount of organic matter and medium amount of total N, low available P and deficient exchangeable K (PCARR, 1980).

Table 5. Soil chemical properties before planting and after harvest of NSIC Rc218 as influenced by water and fertilizer applications

Treatment	Soil pH	Organic matter (%)	Total N (%)	Available P ($mg\ kg^{-1}$)	Exchange-able K ($mg\ kg^{-1}$)
Initial Soil Analysis	5.45	4.61	0.29	1.78	41.27
Final Soil Analysis					
Water Management					
WM_1= Flooded	5.75a	4.14	0.24	1.15	54.84a
WM_2= AWD	5.34b	4.27	0.24	1.16	48.26b
HSD 0.05	*	ns	ns	ns	*
Fertilizer Management					
T_1 = No fertilizer (Control)	5.55	4.02	0.22	0.78b	44.99b
T_2= 100-60-60 kg N, P_20_5, K_20 ha^{-1} RRIF)	5.53	4.09	0.25	1.13ab	77.26a
T_3= Vermicast 10 t ha^{-1} (RRVC)	5.68	4.53	0.26	1.17ab	49.96b
T_4= 75% RRIF + 25% RRVC	5.48	4.29	0.24	1.40a	60.50a
T_5= 50% RRIF + 50% RRVC	5.49	4.19	0.25	1.26ab	43.47b
T_6= 25% RRIF + 75% RRVC	5.58	4.14	0.26	1.18ab	44.12b
HSD 0.05	ns	ns	ns	*	*

Means within column followed by the same letter are not significantly different at 5% level, HSD.
Soil Chemical Properties was analyzed at Central Services Laboratory, VSU, Visca, Baybay City, Leyte.

In the final soil analysis done after harvest, it was found that soil pH and exchangeable K were significantly (p<0.05) affected by water application. Specifically, the value of exchangeable K ($mg\ kg^{-1}$) significantly increased to 13.57. The soil pH under flooded condition, also increased to 0.30 indicating that the soil pH changed towards neutral after the soil's being exposed to continued submergence in water.

In contrast, the amount of OM, total N and available P were not significantly (p<0.05) affected by water application (Table 5). Regarding the effects of fertilizer application, results of the final soil analysis showed that only available P (mg kg^{-1}) and exchangeable K (mg kg^{-1}) were significantly influenced by fertilizer treatments (Table 5). The amounts of organic matter (% OM) and nitrogen (% total N) in the soil also decreased after rice was planted. These results could be attributed to crop removal and some of the nutrients were lost through runoff brought about by heavy rains and during irrigation.

Amount of Water Received by the Rice Plants

The total amount of water received by rice plants throughout the growing period was 15,349 m^3 ha^{-1} under flooded condition and 12, 431 m^3 ha^{-1} under AWD (Table 6). These amounts of water came from the rain (9,020 m3) and from the irrigation water added to the field (6,329m3) in flooded plots and (3,411m3) in the AWD plots. Data shows that under AWD application, the amount of irrigation water added to the field was only 53% of the irrigation water. This means that AWD water application was able to save 47% of irrigation water without affecting the crop yield.

Table 6. Total amount of water received by the rice plant (supplied and from the rain) in the field m^3ha^{-1} from land preparation up to 2nd week before harvesting of NSIC Rc218

Treatments	Amount of water from the rain (m^3ha^{-1})	Amount of water from irrigation (m^3ha^{-1})	Total water received by the rice plant (m^3ha^{-1})
WM_1= Flooded	9,020	6,329	15,349
WM_2= AWD	9,020	3,411	12,431
Difference on water applied to the field		53.89 %	80.98%
Amount of water saved		46.11%	19.02%

Cost and Return Analysis

Results revealed that plants grown under flooded condition produced a net income of PhP 38,808 ha^{-1} and PhP 38,838 ha^{-1} for AWD condition (Table 7). On the other hand, fertilizer treatments applied with 100-60-60 kg N, P_20_5 & K_20 ha^{-1} (RRIF) generated the highest net income of PhP 66,915.00 ha^{-1} and treatments applied with 75% RRIF + 25% RRVC PhP 60,440.00 ha^{-1} , followed by treatments without fertilizer application PhP 40,375.00 ha^{-1}, 50% RRIF + 50% RRVC PhP 39,215.00 ha^{-1} and 25% RRIF + 75% RRVC PhP 25,257.00 ha^{-1}. Variations on the net income from different treatments were due to low yield under treatments without fertilization and treatments applied with pure vermicast and 75% RRVC. Also the cost of purchasing vermicast and labor in hauling and application added to the cost of production, thus resulted in a negative net income of PhP11, 265.00 ha^{-1}.

Table 7. Cost and return analysis of NSIC Rc218 rice production ha^{-1} as influenced by water and fertilizer applications, DS 2014, Baybay City, Leyte

Treatments	Grain Yield (kg ha^{-1})	Gross Income (PhP ha^{-1})	Production Cost (PhP ha^{-1})	Net Income (PhP ha^{-1})
Water Management				
WM_1 = Flooded	4,150	87,150	48,342	38,808
WM_2 = AWD	4,330	90,930	52,092	38,838
Fertilizer Management				
T_1=No fertilizer (Control)	3,340	70,140	29,765	40,375.00
T_2= 100-60--60 kg N, P_20_5 & K_20 ha^{-1} (RRIF)	5,180	108,780	41,865	66,915.00
T_3= Vermicast 10 t ha^{-1} (RRVC)	3,500	73,500	84,765	-11,265.00
T_4= 75% RRIF + 25% RRVC	5,030	105,630	45,190	60,440.00
T_5= 50% RRIF + 50% RRVC	4,530	95,130	55,915	39,215.00
T_6= 25% RRIF + 75% RRVC	3,740	81,060	55,803	25,257.50

Current price for dried palay in Leyte= PhP 21.00/kg

The potential, positive contribution of vermicast to any yield through the improving physical properties of soil that cannot be accounted for since this study was done only for one cropping.

CONCLUSIONS

1. Plants grown under flooded conditions significantly grew taller with broader leaf area and matures later but few number of tillers $hill^{-1}$ but, were not significantly different in terms of yield compared to there plants grown in AWD conditions. Likewise, plants applied with RRIF at the rate of 100-60-60 kg N, P_20_5 and K_20 ha^{-1} significantly produced more productive tillers $hill^{-1}$, longer panicle length, more number and high percent filled grains $panicle^{-1}$ and heavier weight of 1000 grains (gms) resulted in higher total grain yield in t ha^{-1} relative to the untreated plants.
2. Only the weight of 1000 grains showed a significant interaction effect between water and fertilizer applications of irrigated lowland rice NSIC Rc218;
3. A positive correlation was noted between yield and other yield contributory characters of irrigated lowland rice NSIC Rc218 except on the number of spikelets $panicle^{-1}$. Productive tillers were highly correlated to yield while panicle length, percent filled spikelet per panicle, weight of 1000 grains (g) and leaf area index were significantly correlated to yield.

4. No significant differences on the net income per hectare of irrigated lowland rice NSIC Rc218 under two water applications were found. Plants applied with RRIF 100-60--60 kg N, P_20_5 & K_20 ha^{-1} generated the highest net income of PhP 66,915.00 ha^{-1}.

RECOMMENDATIONS

1. To save a substantial amount of water, it is recommended that irrigated lowland rice be grown under AWD water system to maintain the soil at moist condition and should be sprayed with pre-emergence herbicides once to minimize the presence of weeds as well as the cost of weeding.
2. Further study needs to be conducted in areas where dry season is very pronounced like in the province of Nueva Ecija.
3. Likewise, another study maybe conducted with more cropping to verify further the effects of the vermicast organic fertilizer in improving the soil properties and in enhancing rice productivity.

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