INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY: APPLIED BUSINESS AND EDUCATION RESEARCH
2023, Vol. 4, No. 7, 2173 – 2179
http://dx.doi.org/10.11594/ijmaber.04.07.02

Research Article

Comparative Yield Performance of Rice Production Under Organic and Inorganic Fertilizer Application

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Article history:
Submission April 2023
Revised July 2023
Accepted July 2023

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ABSTRACT

The technology demonstration on rice production under organic and inorganic fertilizer application was conducted to determine which of the identified treatments would give better rice growth and yield and showcase the technology to the farmers. The study was composed of three treatments. Treatment A – Inorganic Fertilizer (120-60-60); Treatment B – ½ of 50% Inorganic + 50% Vermicast RR; Treatment C – 25 bags of vermicast as organic fertilizer. An area of 778.18 square meters was divided into three plots with a measurement of 19.30 meters in length and 12.44 meters in width (19.30m x 12.44m). Between plots was provided with a 1-meter distance for the passageway and drainage for excess water. The research made use of frequency and mean to determine the growth and yield performance of NSIC Rc 160 (Tubigan 14) as applied with organic and inorganic fertilizers. Treatment variation was analyzed using one-way ANOVA. The result of the study shows that the application of inorganic and organic fertilizers gave a comparable performance in terms of growth and yield performance. However, in terms of a cost analysis of using inorganic and organic fertilizers, it is more economical to use organic fertilizer than inorganic fertilizer. It further showed that the lower the cost of production, the higher the net income of the rice production under organic fertilizer application. The researcher further concluded that the application of vermicast alone as a fertilizer source or a combination of inorganic and organic fertilizers is more cost-efficient in rice production than purely inorganic fertilizer application.

Keywords: *Demonstration, Inorganic, Organic, Rice Production, Vermicast*

Introduction

The Department of Agriculture (DA) has raised concerns regarding the persistent increase in the population rate in the Philippines. The current annual growth rate of 2.04% poses a significant challenge to meeting the country's rice production requirements. The DA has projected that by 2030, the nation must increase its rice production by 0.4 - 0.5 t/ha to sustain the population's growing demands (DA, 2018).

How to cite:
Dollison, M. D. (2023). Comparative Yield Performance of Rice Production Under Organic and Inorganic Fertilizer Application. *International Journal of Multidisciplinary: Applied Business and Education Research*. *4*(7), 2173 – 2179. doi: 10.11594/ijmaber.04.07.02

This projection highlights the pressing need for the agriculture sector to develop innovative strategies and implement effective measures to address the imminent food security concerns in the Philippines. According to the medium and high assumptions used by the Philippine Statistical Analysis (PSA), the population of the nation will be 128 million and 131 million, respectively, in 2030. These projections indicate that the demand for rice will continue to increase, creating a considerable challenge for the agriculture sector to meet the food requirements of the growing population (PSA, 2018).

In addition, rice is a staple food in the Philippines, most of the population is dependent on its availability. Due to its significance, rice has become the most politically sensitive commodity in the country. The government considers ensuring a reliable supply of adequate, stable, affordable rice a top priority. However, achieving the vision of a good rice supply faces numerous challenges. One of the primary factors threatening rice production in the Philippines is climate change, which has led to erratic weather patterns and extreme weather events, such as droughts and floods, affecting the productivity of rice fields. Additionally, unproductive soils due to soil acidity, pests, and diseases impede rice production performance. Likewise, the increasing population rate in the country adds to the pressure on rice supplies. The population growth rate of 2.04% annually poses a considerable challenge to the agriculture sector to meet the rising demand for rice (DA, 2018). As a result, the government and the agricultural industry must address these issues effectively and efficiently to ensure a sustained rice supply in the Philippines.

Recent concern about rice self-sufficiency resulted in the adoption of different technologies that resolved the country's epidemic problems of rice crop production shortage. The utilization of high-quality inbred rice seeds and nutrient management using organic and organic fertilizers are contributing factors in increasing local farmers' rice production. To increase agricultural crop production, allocating and combining various production factors, including land, labor, fertilizers, seeds, pesticides, and other necessary inputs, is essential. Fertilizers provide plants with essential nutrients to promote their growth and increase yields. The optimum fertilization strategies can increase productivity, enabling farmers to meet the rising demands for food production in the ever-growing global population. (Fahmid et al., 2022).

In rice production, fertile soil is the primary basis for crop production primarily because it is where the nutrients are vital for the performance, such as growth and yield of plants (Eroa, 2015). In addition, the application of organic fertilizer and inorganic fertilizers is effective in enhancing the growth and yield components of rice. These results have the positive potential for reducing the use of chemical fertilizers without decreasing the yield of rice (Moe et al., 2017). According to Hayne & Naidu (1998), as cited by Sumagaysay (2016), inorganic and organic fertilizers are good sources of essential nutrients required for plants to produce better growth performance and optimum yield of rice.

For a considerable period, the Philippines has remained a net importer of synthetic fertilizers. About 90% of the country's fertilizer needs are sourced from other countries, notably China, Indonesia, and Malaysia. A small fraction of the fertilizers are imported from Qatar, Canada, Korea, and the Middle East. In contrast, local fertilizer production contributes only 10% of the country's fertilizer supply. This significant dependence on imported synthetic fertilizers exposes the country to supply chain disruptions, price fluctuations, and other risks that may adversely affect agricultural productivity and food security (FDA, 2021). Thus, increasing fertilizer costs will result in limited fertilizer application and decreased crop performance due to a deficiency in essential nutrients to supply plant growth.

Conventional farming systems are predominant among rice Pilipino farmers, who depend heavily on inorganic fertilizers, notably urea, which contains 46% nitrogen, and diammonium phosphate (DAP), which contains 46% phosphorus and 18% nitrogen, to increase paddy rice yield. Such farming practices are characterized by high input usage, often in excessive amounts, and may lead to soil degradation, water pollution, and reduced productivity in the long term. However, inorganic fertilizers have increased crop yields in the short term (Kakar et al., 2020). According to Zhou et al. (2022), organic fertilization practices can yield multiple benefits for rice crop production and soil quality. Such practices have enhanced soil fertility, structure, and nutrient availability while increasing the organic carbon content and providing a nutrient-rich food source for microorganisms. Applying organic fertilizers can also significantly shift the composition of the microbial community and increase microbial diversity. Furthermore, organic fertilization can alter the soil cation exchange capacity (CEC) and soil moisture content, leading to changes in the community structure and composition of soil fauna in acidic soils. Overall, organic fertilization practices offer a promising alternative to conventional farming systems, promoting sustainable and eco-friendly approaches to agricultural production.

Hence, this technology demonstration approach to rice production under organic and inorganic fertilizer application was conducted to evaluate which fertilizer application would give better growth, yield, and lowest production cost per hectare. This study will serve as fertilizer options for rice farmers in utilizing organic, inorganic, or a combination of organic and inorganic in order to reduce the cost of fertilizer inputs.

Methods

Experimental Area/Site

An area of 778.18 square meters of lowland rice fields intended for rice seed production of the college beside the College of Agriculture building was used as a Technology Demonstration site. The area was thoroughly prepared before planting. It was plowed and harrowed twice with a week interval to fasten the decomposition of weeds and previous crop stubbles. After the final harrowing, three plots were constructed, measuring 19.30 meters in length and 12.44 meters in width (19.30m x 12.44m). Between plots was provided with a 1-meter distance for the passageway and drainage for excess water.

Planting and Fertilizer Application

NSIC Rc 160 (Tubigan 14) was used as a test crop for demonstration research. After land preparation and experimental layout, the 20-day-old seedlings were transplanted in the three experimental plots. Fertilizers, both organic and inorganic source, plays a vital role in the crop life cycle. The demonstration research uses the general recommendation for rice production for organic and inorganic fertilizer application. The fertilizer treatments per plot were assigned as follows: Treatment A – Inorganic Fertilizer (120-60-60 kg/ha); Treatment B – (Inorganic + Vermicast); Treatment C – Vermicast (25 bags/ha). Split application of Inorganic fertilizers (treatment A and treatment B) was made one week after planting and during panicle initiation. Organic fertilizer was applied after the final layout of the study.

Data Gathered

Plant Height at Harvest (cm). It is the average height of the ten randomly selected samples per treatment/plot. Measurements were done by placing the meter stick from the soil level to the longest extended leaf.

Days to flowering (Days). The number of days to flowering was counted and recorded from sowing until the plants start to open the florets, the anthers protrude, and pollen is shed. Recorded data on the number of days to flowering was summed up, and it was divided by ten to get the average.

Days to Maturity. The maturity of the rice crop was observed by counting the number of days from transplanting up to harvesting. This event was observed from the ten representative samples per treatment.

Productive Tillers/hill. Productive tillers were counted during harvesting. This event was observed from the 10 representative samples per treatment.

Weight of Hundred Grains (g). One thousand seeds from the ten representative samples per treatment were collected and weighed using the standard weighing scale or triple beam balance to get the accurate weight of rice grains. The collection of thousand grains was done during harvesting.

Average Weight of Fresh Palay (grams). Fresh weight was gathered from the 25 randomly selected plants during harvesting.

Average Weight of Dried Palay (grams). Fresh weight was gathered from the 25 randomly selected plants during harvesting.

Yield per Hectare (Tons). Yield per treatment/plot was gathered from the three quadrants per plot. Each quadrant will have a measurement of 1m2.

Crop Production Maintenance

Ten days after planting, irrigation water was introduced to each experimental plot. A 5 cm water height was maintained for the three experimental plots a month before harvesting. The area was closely monitored to detect pests that attacked the crop early. If the pest occurs, Integrated Pest Management is employed to avoid the excessive use of pesticides.

Harvesting

Harvesting was done when 80 % of the grains in the panicle were golden yellow. Harvested palay per treatment was subjected to threshing and drying separately to ensure that there was no mixture of seeds per treatment.

Statistical Tools

The research made use of frequency and means to determine the growth and yield performance of NSIC Rc 160 (Tubigan 14) as applied with organic and inorganic fertilizers. Treatment variation was analyzed using one-way ANOVA of Statistical Package for the Social Sciences (SPSS).

Results and Discussion

Plant Growth Performance of NSIC Rc 160 variety under organic and inorganic fertilizer application

The result of the study shows that rice crops applied with synthetic fertilizer obtained the tallest height, followed by a combination of synthetic and organic fertilizer, and the shortest height was obtained by treatment with organic fertilizer. However, statistical analysis shows that the application of organic and inorganic fertilizers revealed no significant effect on the height of the crop. In terms of days to flowering, it was observed that synthetic fertilizer application and organic fertilizer application did not significantly differ in the number of days to flower. Likewise, the number of days to maturity of rice was not affected by the kind and combination of fertilizer applied. It was also observed that the growth performance of Tubigan 14 rice variety had a shorter height, early to bear flower, and early days to maturity compared to the standard morphological characteristics established by Philippine Rice Research Institute. The non-significant performance of the tested fertilizer treatments shows that both organic and synthetic fertilizers will give better results in terms of rice growth characteristics. Furthermore, the utilization of organic fertilizer for crop production is a good source of essential nutrients. It improves soil physical and chemical properties when continuously applied to the soil than using inorganic fertilizer (Kumar Bhatt et al., 2019).

Table 1.0 Plant Growth Performance of Tubigan 14 (NSIC Rc 160) rice variety under organic and inorganic fertilizer application

Treatment	GROWTH PARAMETERS		
	Plant Height (cm)	**Days to Flowering**	**Days to maturity**
Treatment A – Inorganic Fertilizer	91.05	74.60	104.60
Treatment B – 50% Inorganic and 50% Vermicast	90.65	74.70	104.40
Treatment C – 25 bags of vermicast	84.44	73.50	103.40
Standard Morphological Characteristics (Philrice, 2007)	**96.00**	**87.00**	**122.00**

Yield Performance of NSIC Rc 160 variety under organic and inorganic fertilizer application

Table 2.0 presents the yield performance of Tubigan 14 rice (NSIC Rc 160) variety under organic and inorganic fertilizer application. Based on the result of the study, both organic and inorganic fertilizer applications to rice crops did not affect the number of tillers produced per plant. Similarly, the weight of thousand grains of tested crops did not differ when applied with organic and inorganic fertilizers. Furthermore, organic and inorganic fertilizers did not affect the fresh and dry weight of grains in grams of the tested rice varieties. The result further revealed that the application of inorganic, organic, and combined fertilizers did not significantly affect the yield performance of the tested crop. The result of the study also signifies that crop responses in terms of yield performance had similar effects despite the different fertilizer characteristics of the inorganic and organic fertilizers used in the study. Yield performance was lower compared to the standard morphological characteristics established by PhilRice, which is 5.6 tons/hectare average yield. The lower yield was attributed to the differences in the growing environment of the crop that influenced the attainment of its maximum yield capacity. The result of the study contradicts the study of Anisuzzaman et al. (2021) that the significant yield of rice is higher in chemical fertilizer application alone or in combination with organic and inorganic fertilizers only. Likewise, the result of the study was supported by Olabisi et al. (2015), that the average yield of full organic rice practitioners is 3.0 tons/hectare, while inorganic rice practitioners, the yield is 5.04 tons/hectare. In addition, the yield response of rice in the organic and organic fertilizers applied meets the average play production of the country, which was 3.97 in 2018 and 4.10 tons/ hectare (PSA, 2018).

Table 2.0 Yield Performance of Tubigan 14 (NSIC Rc 160) rice variety under organic and inorganic fertilizer application

Treatment	YIELD PARAMETERS				
	Productive Tillers/hill	**Weight of Thousand Grain (g)**	**Fresh Weight (g)**	**Dried Weight (g)**	**Yield / Hectare in Tons**
Treatment A – Inorganic Fertilizer	11.80	3.4	4,515	3,625	4,008
Treatment B – 50% Inorganic and 50% Organic	11.40	3.68	4,660	3,982	4,127
Treatment C – 25 bags of vermicast/vermicompost	11.10	3.74	4,125	3,513	3,065
Standard Morphological Characteristics (Philrice, 2007)					**5.6 (Ave.)**

Cost Analysis of Inorganic and Organic Fertilizers Application/Hectare of rice production

Table 3.0 shows the fertilizer cost of one-hectare rice production using inorganic and organic fertilizers. The cost analysis shows that applying inorganic fertilizer/synthetic fertilizer to one-hectare rice production is more costly than applying organic fertilizer. The result further implied that it is more economical to use organic fertilizer than inorganic fertilizer. The lower the cost of production, the higher the net income of the rice farmers engaging in rice production using organic fertilizer. The price fluctuation of inorganic fertilizer in the market, especially during planting season, significantly affect the application of the exact amount of fertilizer to rice crop, thereby affecting the crop yield potential. Likewise, organic fertilizer application is the best option for rice farmers to avoid the regular use of synthetic fertilizer in their respective farms.

Table 3.0 Cost Analysis of Inorganic and Organic Fertilizers Application/Hectare of rice production

Particular	Quantity	Unit Cost Total	Total
A. In-organic Fertilizer			
1. Ammonium Phosphate (16-20-0)	1 bag	1,325.00	1,325.00
2. Complete Fertilizer (14-14-14)	4 bags	1,400.00	5,600.00
3. Urea (46-0-0)	1 bags	1,400.00	1,400.00
4. Muriate of Potash (0-0-60)	0.5 bag	1,350.00	675.00
Sub Total	**6.5 bags**	**5,474.00**	**9,000.00**
B. Organic Fertilizer			
1. Vermicast	25 bags/50kg/bag)	300/bag	7,500.00
Sub Total		**300.00**	**7,500.00**

Conclusion

Based on the results of the study, it can be concluded that the growth performance tested was not significantly affected by the kind and amount of inorganic and organic fertilizer application. Furthermore, the kind and amount of inorganic and organic fertilizer application did not yield significant results in all observed yield characteristics. These findings suggest that the use of organic fertilizer, specifically vermicast or vermicompost, may be more economical than inorganic fertilizer for agricultural purposes.

These conclusions are significant in providing insight into the effectiveness of various fertilizers in promoting plant growth and yield. The results suggest that the choice of fertilizer type and application amount may not be critical factors in promoting growth and yield. Therefore, farmers and agricultural practitioners may benefit from considering the economic and environmental advantages of using organic fertilizers over inorganic fertilizers. Future studies may build upon these findings to further explore the efficacy of different fertilizer application types and amounts in promoting plant growth and yield.

Recommendation

The researcher recommends several recommendations to promote sustainable and cost-effective agriculture based on the aforementioned conclusion. Firstly, the utilization of vermicast or vermicompost as a source of fertilizer for rice production is highly recommended. This organic fertilizer has been found to be more economical than inorganic fertilizers and can also promote sustainable livelihoods for farmers.

Secondly, it is advisable to apply organic fertilizer in a proportionate manner to avoid yield drop. The correct and timely application can ensure the crop receives the necessary nutrients while minimizing potential negative effects on yield.

Lastly, vermicomposting should be produced within the farm to lessen the expenses of seed production. This practice can help reduce the cost of production, and the produced vermicompost can also be used to fertilize crops within the same farm.

These recommendations have significant implications for agricultural practices and can help promote sustainable and cost-effective agriculture. Future research may build upon these recommendations to explore their effectiveness in different agricultural contexts and provide further insight into best practices for organic fertilizer application.

Acknowledgment

Sincere thanks are extended to the administration, the College of Agriculture faculty, and agriculture students for helping the researcher to come up with this research.

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