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Ratooning response of lowland rice (*Oryza sativa* L.) varieties to Aloe vera (*Aloe barbadensis* Miller) foliar fertilizer application

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Abstract

The study sought to determine the response of ratoon lowland rice (*Oryza sativa* L.) varieties to foliar application of Aloe vera (*Aloe barbadensis*, Miller) extracts as a natural fertilizer. Determine the best *Aloe barbadensis* extracts to produce higher ratooned productivity. Evaluate the profitability of rice ratooning sprayed with *Aloe barbadensis* extracts at the different application strategies. Rice varieties were used as the main plot and foliar fertilization strategies as the subplot. Results revealed that *Aloe barbadensis* extracts significantly promoted the plant height of PSB Rc22 than NSIC RC216, but the latter variety achieved slightly higher productivity than the former. Spraying of fermented young *Aloe barbadensis* extracts produced a higher grain yield as compared to other treatments due to the abundant proliferation of productive tillers. The comparison of lowland rice varieties and foliar application of *Aloe barbadensis* extracts did not influence the agronomic and yield components of said crops except plant height, and this might be due to exposure of ratoon plants to high maximum temperatures. Economic analysis showed a high gross margin (USD 429.90) of ratooned NSIC Rc216 was due to the application of fermented young *Aloe barbadensis* extract as mainly attributed to the high grain yield (2.13 t ha^{-1}) of the ratoon plants. The result of this study is a promising option in rice areas that are experiencing normal environmental conditions with problematic soil conditions which hinted at the application of granular fertilizer. This is the best alternative if supplemented with inorganic fertilizer as part of its fertilization process in attaining higher productivity.

Keywords: Aloe vera, Commercial fertilizer, Natural foliar fertilizer, Ratooning response

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Introduction

Rice (*Oryza sativa* L.) is one of the most important cereal crops and is considered a staple food crop for about half of the world's population (GRISP, 2013). Khush (1997) reported that more than 90% of the world's rice is grown and consumed in Asia, where 60% of the earth's people live. In the Philippines, this crop plays a vital role in our national food security and is a means of livelihood for rural households. Every year rice production should suffice the needs of the growing population in the country since the population increases arithmetically. One of the practices to increase rice production and lessen crop production time is choosing the suitable variety and proper ratoon practices.

Rice ratooning is the process of regenerating the production of new tillers after harvesting the previous crops and this is considered the best option to increase rice production per unit area and per unit of time (Chauhan et al., 1985). The first harvest of a crop is called a principal crop, and each succeeding harvest is designated the first ratoon, second ratoon, and so on. The importance of ratoon cropping to enhance yield without increasing the land area and, at a lesser per unit production cost, has been emphasized. Rice ratooning is less labor-intensive since it does not require tillage, seeds, transplanting, and lesser cost in crop maintenance (Banoc & Asio, 2019). To improve the strategies of ratooning and increase production, enhancing its nutrients for proper plant growth and development is a must.

Foliar application is a widely used crop nutrition strategy for increasing performance and improving crop growth and development. The foliar application may be more environmentally friendly and target-oriented since nutrients can be taken up by leaves (Marschner, 2012) and directly transported to plant tissue during the stage of plant growth and development. Foliar spraying encourages the uptake of nutrients from the soil. After spraying, the leaves produce more carbohydrates, which are transported to the root and released as exudates. It boosts microbial activity in the soil, allowing microbes to grow around the root mass, and increasing the number of nutrients available to the plants (Jacoby et al., 2017)). One strategy for improving the grain yield of ratoon plants is through foliar application of natural fertilizer. Aloe vera (*Aloe barbadensis)* is one of the identified natural fertilizers that can suffice the growing ratooned crop's need to boost rice productivity and income.

The information on rice ratooning using *Aloe barbadensis* as organic foliar fertilizers is limited. Hence, this study sought to determine ratoon lowland rice (*Oryza sativa* L.) varieties' response to foliar application of *Aloe barbadensis* extract as a natural fertilizer. Determine the best Aloe vera extract to produce a higher ratooned yield. Evaluate the profitability of rice ratooning applied with *Aloe barbadensis* extracts at the different application strategies.

Aloe vera (L.) Burm is a succulent plant species that grow well in the tropics (Heraldkeepers, 2022). This crop belongs to the Liliaceae family which is considered a traditional medicinal plant that can treat various illnesses such as cancer, and skin disorders including wounds (Razia et al., 2022). Razia et al. (2022) further stipulated that Aloe vera has a significant wound healing effect targeting microfibril-associated glycoprotein (MFAP4) and its associated signaling pathway useful for human and animal health. Besides, Aloe vera-containing gel has an excellent ability as an antioxidant due to flavonoid content (Wariyah et al., 2022).

Relative to Aloe vera extracts, its market is expected to exceed US$ 2,344.2 M by 2024 (Heraldkeepers, 2022). However, according to Expresswire (2022) that the market of Aloe vera extracts is valued at an estimated amount of 1,095.4 US dollars with anticipation of increasing its growth by more than 5.4% CAGR, thus projected to attain 1,501.8 M US dollars by 2022 – 2026. Thus, the increasing growth rate was segmented into product forms such as gels, liquid, capsules/tablets, powder, oil, foliar fertilizer, etc. (MordorIntelligence, 2022). Thereby, the global Aloe vera market is increasing to 7.2% CAGR during the forecast period from 2019 until 2024. As such the enhancing market is primarily driven by fast-informing awareness of medicinal properties relative to treating diabetes, skin, and hair diseases. Aloe vera extracts can be used for personal care like cream, lotion, soap, shampoo, and ingredients for food and beverages.

Aloe vera comes from the Arabic word "Alloeh" meaning shining bitter substance while vera means in Latin the word "true". This is also called the plant of immortality by the Egyptians. This plant is rich in nutrients, enzymes, and over 75 useful compounds which include amino acids, antioxidants, composite carbohydrates, calcium, magnesium, zinc, vitamins A, C, E, B complex, etc. (Deanne, 2021) that offer various benefits to plants, as a source of natural fertilizer. In effect, this can enhance seed germination, faster the development of roots, boost cell strength, and provide comprehensively better plant health, growth, and vigor if used as a natural fertilizer (Deanne, 2021). Similarly, Aloe vera contains 75 potentially active ingredients such as vitamins, enzymes, minerals, sugars, lignin, saponin, salicylic and amino acids (Atherton, P. 1997; Shelton, M, 1991). It has a gel component that consists of more than 98.5% water with the remaining solid particles consisting of beyond 200 various components, polysaccharides which are largely the most abundant parts (Minjares-Fuentes & Femenia, 2019).

This plant has been reported to contain numerous chemical components that include anthraquinone compounds, glucoside, lipids, polysaccharides, organic acids, enzymes, amino acids, antibiotics, and vitamins (Li, 2009). These non-synthetic compounds play a major role in strengthening plants' character and capacity (El-Saadony et al., 2021, Saad et al., 2021a, Saad et al., 2021b). Thus, the foliar spraying of Aloe vera might attribute to increasing sugar content in plant cells that eventually increase the osmotic pressure that promotes translocation of water and solutes into the cells, thereby increasing their size and ability to combat water stress.

Therefore, Aloe constitutes an essential part of various antioxidant enzymes that own a contrasting volume of minerals such as Cu, Zn, Mn, and Fe (Jain et al., 2014). Such minerals could have played a demanding activity in increasing plant resistance to drought stress (Marschner, 2012). In the event of drought, plants would not be able to get the exemplary volume of nutrients that antagonistically influence the comprehensive conditions of plants, particularly their growth and fruit traits (Abdou et al., 2022). These essential plant nutrients; i.e., zinc, copper, iron, and manganese are among the needed nutrients for better plant growth and development to complete their life cycle that consecutively increases the concentration of the antioxidant and develop drought tolerance in plants (Waraich et al., 2011).

Materials and Methods

Study site

The study was conducted in the experimental field of the Department of Agronomy, Visayas State University (VSU), Visca, Baybay City, Leyte, Philippines, where there is an adequate water source from April 17, 2021, until June 10, 2021. An experimental area was constructed with dikes and canals around each treatment plot to facilitate water management.

Soil sampling and analysis

After harvesting the primary crop, five soil samples were collected randomly from the experimental field using a soil auger. The soil samples were mixed entirely, air-dried for several days, pulverized, and sieved thoroughly in a wire mesh (2 mm) before submission for analysis to the Central Analytical Services Laboratory (CASL), PhilRootcrops, Visayas State University, Visca, Baybay, Leyte (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 by ammonium acetate extraction atomic absorption spectrophotometry (ISRIC, 1995).

Another five soil samples were also collected from each treatment plot after harvesting the ratoon crop to represent as final soil analysis. All samples were composited separately, following a similar procedure as the initial soil sampling. These were also processed and submitted for analysis similar to the initial soil samples.

Experimental design and treatments

The experiment was set out in a split plot in a Randomized Complete Block Design (RCBD) with three replications. The primary plot treatment was the lowland rice varieties used, and the subplot was the foliar fertilizer application of (*Aloe barbadensis*, Miller) extracts. Each treatment plot was measured 2 m × 5 m with alleyways of half a meter and one meter between treatment plot and replication, respectively, to facilitate farm operation, management, and data gathering. The different treatments used were designated as follows.

Primary plot treatment: Lowland rice varieties
M_1- NSIC Rc216
M_2- PSB Rc22
Subplot treatment: Foliar application of Aloe vera (*Aloe barbadensis,* Miller*)* extracts
T_1- No foliar fertilizer application (control)
T_2- Spraying of super harvest foliar fertilizer
T_3- Spraying of fermented young Aloe vera (*Aloe barbadensis,* Miller) extracts
T_4- Spraying of fermented matured Aloe vera *(Aloe barbadensis*, Miller) extracts
T_5- Spraying of fresh Aloe vera (*Aloe barbadensis*, Miller) extracts + wood vinegar

Cutting strategies of rice stubbles

After harvesting the main crop, the rice stubbles were cut 30 cm above the soil surface using a sickle. The cutting of rice stubbles was done right after the main crop was harvested, and when the ricefield has still sufficient available moisture appropriate for the growing ratoons.

Preparation and application of Aloe vera extracts

The preparation of Aloe vera (*Aloe barbadensis*, Miller) foliar fertilizer was kept simple to make it accessible to rural farmers. One kilogram of freshly harvested *Aloe barbadensis* aloe vera leaves (young and matured) was weighed and washed. The newly harvested *Aloe barbadensis* was chopped into small pieces and placed in a clean container with a clean knife. One kg of molasses was mixed with the chopped *Aloe barbadensis* leaves and placed in a clean container, covered with Manila paper, and fermented for one month.

After fermentation, the fermented *Aloe barbadensis* was extracted using clean cheesecloth, and the liquid material was strained to remove foreign particles that might have clogged up the knapsack sprayer. Fermented *Aloe barbadensis*, Miller (young and matured) were applied weekly at a rate of 250 mL per four liters of water from five days after harvesting the primary crop to the reproductive growth phase of the ratooned crop during the early morning from 5:30 AM to until 7:00 AM. Generally, spraying of Aloe vera extracts and other materials from other treatments was done during the early morning but if the weather conditions will not warrant during the early morning time, the foliar application through the use of a knapsack sprayer was conducted late in the afternoon, from 4:30 PM to 6:00 PM. However, fresh *Aloe barbadensis* extracts and wood vinegar were applied at a rate of 125 ml for fresh *Aloe barbadensis* extracts and another 125 ml for wood vinegar which was finally mixed with four liters of water.

Water management

For easy management of irrigation water in the experimental field, dikes around each treatment plot were constructed to impound water. Irrigation canals were also constructed around the experimental plot to drain excess water during heavy rainfall. Irrigation was done right after harvesting the main plant at a depth of 2 cm. Intermittent irrigation was started 14 days after harvesting the main plant and continued flooding from heading until two weeks before harvesting the ratooned crop.

Weed management

The proper weed management was employed for the ratoon crop. This was manipulated through a hand weeding operation which started two weeks after harvesting the main plant. The second weeding was done two weeks later to remove the remaining weeds around each hill completely. Then spot weeding operation was done to eliminate the weeds and continuously done until the maximum tillering stage of the ratoon crop.

Pest management

To prevent golden apple snail (GAS) infestation, handpicking of adults and egg masses of GAS (*Pomacea canaliculata* L.) was done after harvesting the main crop. Pesticides were sprayed to control insect pests and diseases. It was done by actual spraying 25 grams Lannate (Methomyl) mixed with 16 liters of water using a knapsack sprayer to prevent rice bugs at the heading stage. In controlling fungal and bacterial diseases, spraying of fungicides and bactericides was done to prevent infections of the aforesaid diseases.

Harvesting

The ratooned plants were harvested within the harvestable area. This was done approximately 85 % of the grains in each treatment plot had ripened as indicated by the firm and amber-colored grains. All panicles of the harvested plants were threshed, cleaned through winnowing, sundried for three days, and tested for seed moisture using a seed moisture tester before data gathering.

Data gathered

The agronomic characteristics of ratoon crops that were gathered were the plant height and fresh straw yield (t ha^{-1}). The plant height (cm) was determined by measuring ten sample hills at random in each treatment plot. For the fresh straw yield (t ha^{-1}), all plants in the harvestable area in each plot were cut from the ground and then weighed without panicles. The plot yield was converted to per hectare bases using the following formula used by Baňoc & Asio (2019). The yield and yield component parameters were the number of productive tillers per hill and the grain yield (t ha^{-1}). The number of productive tillers was determined by counting the tillers that developed panicles from ten sample hills in each treatment plot at maturity. The grain yield (t ha^{-1}) was determined after the grains from the harvestable area of each treatment plot were harvested and threshed. The grains were sundried and cleaned before weighing. The weight per plot was converted into tons per hectare using the formula adopted by Baňoc (2020).

Economic analysis

Economic analysis was determined through the calculation of gross margin. The gross margin was calculated based on the gross income minus the total variable cost; The total variable cost was determined by recording all the expenses incurred from land preparation up to drying. These include the cost of labor and material costs for Aloe vera and foliar fertilizer used. Gross income was determined by multiplying the grain yield per plot by the current price of palay per kilogram and converted to a per hectare basis. The gross margin was determined using the formula:
Gross margin = Gross income - Total variable cost

The economic analysis was determined by adopting the gross margin used by Baňoc & Asio (2019).

Meteorological data collection

Climatic data such as precipitation, temperatures (maximum and minimum), and relative humidity were obtained from the PAG-ASA station located at the VSU.

Statistical analysis

After gathering all the data, means were computed, and an analysis of variance (ANOVA) was done using the Statistical Analysis System (SAS Version 6.12). A comparison of means was made using the Honestly Significant Difference (HSD) or Tukey's test.

Results

Soil chemical analysis

The initial soil analysis was taken from the different treatments of the experimental area (Table 1). The result showed that the soil had the following mean chemical properties: 5.48 soil pH, 3.10 % organic matter (OM), 0.24 % total N, 8.94 mg kg^{-1} usable P, and 0.46 me $100g^{-1}$ of convertible potassium. The final soil analysis revealed that the soil pH, total N, and obtainable P were slightly reduced based on their initial investigations while increasing its OM and convertible K by about one and 28 percent, respectively.

Table 1 Chemical properties of the soil before and after harvesting of ratoon lowland rice (*Oryza sativa* L.) varieties to Aloe vera (*Aloe barbadensis,* Miller*)* foliar fertilizer application

Initial	Soil pH (1:2:5)	Organic matter (%)	Total N (%)	Obtainable P (mg kg^{-1})	Convertible K (me100 g^{-1}soil)
Initial	5.48	3.10	0.24	8.94	0.46
Final	5.47	3.12	0.20	7.88	0.59

Meteorological conditions of the experimental area

The total amount of rainfall throughout the growth duration of the ratooned crop was 125.55 mm (Table 2). The highest precipitation was observed in week seven with 92.6 mm while the lowest was noted in the second week with 0.45 mm. However, the average minimum and maximum temperatures experienced throughout the growing period of the ratoon crop were 24.15 and 41.93-degree centigrade, respectively. The average relative humidity recorded throughout the ratoon's growing period was 83.93 %.

Pests of ratoon crop

During the conduct of the study, the presence of Maya (*Lonchura malacca* Linn.) and Gorion (*Passer montanus* Linn.) that will start to infest the growing ratoon crop will be at the reproductive growth phase. For this research undertaking, the ratoon crop that was established from April to June was only slightly infested with the said pests. Thus, this is the best period for adopting ratoon cropping due to the very limited infestation of the said pests.

Table 2 Data on total weekly rainfall (mm), average daily minimum and maximum temperatures (˚C), and relative humidity (%) during the entire duration of the study, April 16 to June 10, 2021, was obtained from PAGASA Station, Visayas State University (VSU), Visca Baybay City, Leyte, Philippines

Weeks	Total rainfall (mm)	Temperature (°C)		Relative humidity (%)
		Minimum	Maximum	
April 16-22	4.45	24.3	42.8	85.5
April 23-29	0.45	25.8	39.8	79.5
April 30 – May 6	5.2	24.8	41.8	83.5
May 7-13	4.1	24.2	42.2	84.5
May 14-20	9.55	23.8	43.2	86.5
May 21-27	1.0	24.6	41.8	83.5
May 28 – June 3	92.6	24.2	41.5	83.6
June 4-10	8.2	21.5	42.3	84.8
Total	125.55	193.2	335.4	671.4
Mean	15.69	24.15	41.93	83.93

Response of lowland rice varieties to the application of Aloe vera extracts

Table 3 presents the response of two lowland rice varieties; NSIC Rc216 and PSB RC22 to spraying Aloe vera (*Aloe barbadensis*, Miller) extracts at different strategies of application. Statistical analysis revealed that comparing two lowland rice varieties did not significantly ($p \leq 0.05$) affect the number of productive tillers, fresh straw yield (t ha^{-1}), and grain yield (t ha^{-1}) except for the plant height of the ratoon crop. PSB Rc22 remarkably elongated its plant height (87.80 cm) than that of NSIC Rc216 with a height of 85.25 cm. A similar trend was noted in PSB Rc22 achieved a higher number of productive tillers (14.17 tillers) compared to NSIC Rc216 with only 13.55 tillers but this was not significant. Relative to the fresh straw yield (t ha^{-1}) and grain yield (t ha^{-1}), NSIC Rc216, which is known of having an outstanding performance in ratooning produced higher straws (3.63 t ha^{-1}) and grains (1.95 t ha^{-1}) when compared to PSB Rc22 with straw yield and grain yield of 3.41 t ha^{-1} and 1.89 t ha^{-1}, respectively.

Effect of Aloe vera extract application on the growth and yield of ratoon lowland rice

Statistical analysis disclosed that spraying of Aloe vera (*Aloe barbadensis*, Miller) at different strategies of application did not remarkably affect all the parameters gathered such as plant height, the number of productive tillers, the fresh straw yield, and grain yield (Table 3). Although, foliar application of fermented young Aloe vera extracts generally obtained a higher number of productive tillers (14.38 tillers), produced heavier fresh straw yield (3.80 t ha^{-1}), and reaped higher grain yield (2.13 t ha^{-1}) when compared to all other treatments adopted. For the plant height of the ratoon crop, however, spraying of fresh Aloe vera + wood vinegar emanated a higher plant height (87.87 cm) than those of other treatments tested. No interaction effect was noted in all the parameters evaluated.

Table 3 Response of ratoon lowland rice (*Oryza sativa* L.) varieties to spraying of Aloe vera (*Aloe barbadensis*, Miller) natural fertilizer at different strategies of application

Treatment	Plant height (cm)	No. of productive tillers	Fresh straw yield (t ha^{-1})	Grain yield (t ha^{-1})
Lowland rice varieties (a)				
NSIC Rc216	85.25^{b}	13.55	3.63	1.95
PSB Rc22	87.80^{a}	14.19	3.41	1.89
Mean	86.52	13.87	3.52	1.92
F Value	33.21^{*}	6.64^{ns}	0.51^{ns}	0.05^{ns}
Foliar fertilizer application (b)				
T_1= No foliar application (control)	85.67	13.65	3.24	1.76
T_2= Spraying of super harvest	86.35	13.63	3.63	1.85
T_3= Spraying of fermented young *Aloe barbadensis* extracts	86.32	14.38	3.80	2.13
T_4= Spraying of fermented matured *Aloe barbadensis* extracts	86.42	13.80	3.43	1.89
T_5= Spraying of fresh *Aloe barbadensis* extracts + wood vinegar	87.87	13.88	3.50	2.00
Mean	86.52	13.87	3.52	1.92

F value	1.74^{ns}	0.91^{ns}	1.39^{ns}	2.90^{ns}
CV (a) %	1.40	4.96	23.19	36.41
CV (b) %	1.74	5.66	12.45	10.64

Means with the same letter and without letter designations in a column are not significantly different at a 5% significance level, Tukey's Studentized Range (HSD) Test.

Table 4 Production cost per hectare of ratoon lowland rice (*Oryza sativa* L.) varieties as influenced by Aloe vera (*Aloe barbadensis,* Miller) foliar fertilizer at different strategies of application

Treatment	Grain yield (t ha^{-1})	Gross income (USD)	Total variable cost (USD)	Gross margin (USD)
Lowland rice varieties (a)				
M_1 – NSIC Rc216	1.95	624.00	194.10	429.90
M_2 – PSB Rc22	1.89	604..80	194.10	410.70
Foliar fertilizer application (b)				
T_1 – No foliar fertilizer (control)	1.76	563.20	165.60	397.60
T_2 – Spraying of super harvest	1.85	592.00	204.60	387.40
T_3 – Spraying of fermented young *Aloe barbadensis* extracts	2.13	681.60	202.60	479.00
T_4 – Spraying of fermented matured *Aloe barbadensis* extracts	1.89	604.80	202.60	402.20
T_5- Spraying of fresh *Aloe barbadensis* extracts + wood vinegar	2.00	640.00	195.10	444.90

Discussion

The result of the initial analysis implies that the soil is strongly acidic; with a medium amount of organic matter, total nitrogen, and convertible K while possibly deficient in usable phosphorus (Landon, J. R. 1991). During the final soil analysis, the reduction of the total N and usable phosphorus after harvesting of ratoon crop might be due to the utilization of the ratoon crop for its proper growth and development, especially since the ratooned crop was only applied with natural foliar fertilizer. However, the slight reduction of soil pH might be similar to the result of Lupos (2015) that the application of organic fertilizer at different levels resulted in a slight decrease of pH in the soil. Brady & Weil (2017) stated that the decomposition of applied organic matter resulted in the reduction of pH as various acid-forming compounds were released from the addition of organic materials. A slight increase in organic matter and convertible K were observed. It might be due to the mineralization of nutrients from crop residues of the previous cropping, the decomposition of weeds, and decomposed plant materials of the ratooned crop. Chairoj et al. (1984) stated that applying organic fertilizer resulted in the enrichment of readily decomposable organic matter.

Based on the amount of rainfall throughout the growing period of the ratoon crop, it was noted that the quantity of precipitation was far below the recommended amount for growing said crop. This is proved through the in-depth investigation of De Datta (1981) mentioned that the adequate amount of rainfall to produce optimum yield is between 900 – 1,000 mm during the growing season. Thus, the amount of precipitation recorded was inadequate for the growing ratoon crop. However, the growing ratoon crops were not affected by their water requirement since the aforementioned crop was supplied with irrigation water for its proper growth and development starting from vegetative until the ripening growth phase.

Relative to the exposure of the ratoon crop to both minimum and maximum temperatures, it connotes that the maximum temperature experienced by the aforesaid crop was beyond the normal temperature for optimum growth, which ranges from 27 °C to 32 °C as recorded by Yin et al. (1996). Similarly, Luh, 1980 stated that the temperature values recorded did not confirm the temperature condition for the standard vegetative and reproductive development of the rice crop, which normally fluctuates from 20 to 30 ^{0}C from planting to harvesting. Thereby, the maximum temperature values recorded were inappropriate temperatures for the normal growth and development of the ratoon crop. Relative humidity recorded was 83.93 % which was also beyond the optimum relative humidity for rice plants which ranged from 60 to 80% (Weerakoon et al., 2008).

Normally, the lowland rice either main or ratoon crops when reached the reproductive phase will be infested by both Maya (*Lonchura malacca* Linn.) and Gorion (*Passer montanus* Linn.). In this situation, the rice growers controlled said infestations by guarding the entire area daily starting from early morning (5:30 AM) until late in the afternoon (6:30 PM) using driving techniques like producing unwanted sounds, scarecrows, and blinking used tapes to drive away said pests. As observed that the specific period of Maya and Gorion that might inflict severe infestations will not coincide with each other. Maya will mainly infest the plants during heading until the dough stage while Gorion infests remarkably starting from dough until the maturity of the crop. After the dough stage, the normal Maya species will stop infesting the crop aside from those rare "deaf" species, with fewer populations that will continuously infest the crop. For the actual cropping period of the ratoon crop in this study, scheduled from April to June, predictable severe infestations of both Maya and Gorion are rampant since the majority of the rice-growing area was under the turnaround period. In reality, there was a rare presence of both Maya and Gorion during the aforementioned period since it was the actual period wherein birds, Maya, and Gorion were busy caring for their newly hatched offspring (based on a survey from rice farmers). Thus, April to June is the best time for adopting rice ratooning due to the very limited infestation of the said pests. Other common pests attacking ratoon crops, particularly rice bugs were not observed due to preventive spraying of pesticides starting from the panicle initiation stage until the reproductive growth phase.

The response of PSB Rc216 to spraying of fermented young Aloe vera extracts substantially ($p \leq 0.05$) emanated a more extended plant height (87.80cm) when compared to NSIC Rc216 with a plant height of 85.25 cm. The more extended plant height of PSB Rc22 may be due to the plant's genetic make-up in producing greater assimilates intended for the elongation of its culm and faster development of leaves. It conforms with Lupos' (2015) findings that the timely release of available nutrients from organic materials results in the immediate utilization of nutrients of the crops for their early stage of growth. Hartwar et al. (2003) stated that improvement in growth characteristics due to the application of organic fertilizers might be due to the enhanced metabolic activities, which led to an increase in various plant metabolites responsible for cell division and elongation. The result of the study coincided with the study of Hasanuzzaman et al. (2010), which proved that when sufficient nutrients are available to plants, this causes maximum cell elongation or cell division rendering better the size of leaves eventually results in high plant height. Tang (2015) found that applying organic and bio-organic fertilizers enhanced rice production's growth and yield.

However, the insignificant results in this study might be attributed to the insufficient nutrients translocated by *Aloe barbadensis* to the growing ratoon crop, as this was attributed to exposure of the plants to a high mean maximum temperature of 41.93. Although the appropriate temperature requirement for foliar application of various crops is about 21 degrees centigrade (Steffen L. 2020). Thereby the researcher suggested that in areas with consistently high temperatures from early morning till afternoon, then spraying of Aloe vera extracts is advised at night time when the temperature drops considerably. This result is construed with the report of Nutri Ag. (2000) proved that spraying seaweed extracts at high temperatures dries the applied extracts faster resulting in a reduction in the absorption and translocation of nutrient solution within the plant system. Similarly, Das et al., 2014 affirmed that exposure of rice plants to a high temperature above 35 degrees centigrade seriously afflicted the protrusion of panicle, impede flowering, and inferior development of blossoming spikelets. In as much as it reduces the viability and tube length of pollens, low anther dehiscence, and pollen production in the stigma. They further stated that a significant reduction was significantly noted in lowland rice than that of upland rice cultivars.

The effect of spraying foliar fertilizers on the ratoon crop was not significant enough to cause a remarkable influence on the parameters studied. However, the spraying of fermented young *Aloe barbadensis* extracts influenced the number of productive tillers per plant (14.38 tillers), fresh straw yield (38.0 t ha^{-1}), and grain yield (2.13 t ha^{-1}) of lowland rice than those of other subplot treatments tested. It connotes the results of the study of Adigbo et al., 2012 claimed that organic liquid fertilizer is less effective and efficient than inorganic fertilizer. To enhance its productivity, other essential nutrients aside from macronutrients must be applied in adequate amounts if they are deficient in the soil to obtain an excellent ratoon yield (Oad et al., 2002).

Enhancing the capability and effectiveness of spraying foliar fertilizers is essential for an acceptable comprehension of the physical, chemical, biological, and environmental principles that can cope with the total absorption, translocation, and utilization of endowed nutrients by plants. The intricacy of characteristics that modulate the sufficiency of nutrients can be adorned by taking into account the accomplishment of mineral elements and compounds familiar to have conflicting leaf absorption rates and plasticity in plant tissues and organs (Fernandez et al., 2013). Talboys et al. (2020) confirmed that a dual application of topdressing and foliar spraying is one of the utmost strategies in contributing to a more effective and efficient translocating of applied nutrients to effect higher productivity than application singly with liquid organic fertilizer. In this study, the effect of spraying Aloe vera extracts was not effectively used by the ratoon crop, thereby movement of applied Aloe vera extracts was hampered due to the exposure of the ratoon crop to a very high maximum temperature. The effect was noticed in the ratoon plants applied with super harvest commercial foliar fertilizer.

The economic analysis of ratoon lowland rice varieties as influenced by foliar application of *Aloe barbadensis* natural fertilizer shows that NSIC Rc216 (improved variety) obtained a higher gross income (USD 624.00) than PSB Rc22 with a gross income of USD 604.80 (Table 4). The former variety achieved a high gross margin (USD 429.90) compared to the latter with a gross margin of USD 410.70. Ratoon rice plants sprayed with fermented young *Aloe barbadensis* extracts (T_3) obtained a higher gross income (USD 681.60) and higher gross margin (USD 479.00) when compared to all other subplot treatments tested. It was followed by ratoon plants sprayed with fresh *Aloe barbadensis* extracts + wood vinegar (T_5), sprayed with fermented matured *Aloe barbadensis* extracts (T_4), non-applied control plants (T_0), and lastly, those ratooned rice plants sprayed with super harvest synthetic foliar fertilizer (T_2) with gross margins of USD 444.90, USD 402.20, USD 397.60, and USD 387.40, respectively.

The analysis showed that the high gross margin of NSIC Rc216 was mainly attributed to the high grain yield (1.95 t ha^{-1}) of the ratoon plants. The increased gross margin of ratoon rice plants sprayed with fermented young *Aloe barbadensis* extracts (T_3) was mainly attributed to a high grain yield (2.13 t ha^{-1}) and considerable total variable cost (USD 202.60) incurred of the ratooned crop that eventually resulted in a higher gross margin.

Conclusion and Recommendation

Spraying of fermented young *Aloe barbadensis* extracts at the rate of 250 ml per four liters of water for eight weekly applications enhanced the plant height of ratoon lowland rice var. NSIC Rc216. Eight weekly sprayings of young *Aloe barbadensis* natural foliar fertilizer did not remarkably increase the yield of the ratoon crop but obtained a higher fresh herbage yield (3.80 t ha^{-1}). Spraying of fermented young *Aloe barbadensis* extracts regardless of variety gave a higher gross margin (USD 479.00) compared to all other subplot treatments adopted. Spraying fermented young *Aloe barbadensis* extracts at a higher application rate might be a feasible option for increasing the productivity of ratoon lowland rice even in areas that experienced unpredictable weather conditions.

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