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Effect of Varying Levels and Brewing Durations of Vermitea on the Performance of Rice and Pest Occurrence

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Abstract

Continuous use of inorganic fertilizer and pesticide in rice production has led to increasing cost of farm inputs, reduction in yield and environmental threats. For this reason, the varying levels of vermitea and different brewing durations were tested to: 1.) determine the effect on the growth and yield performance of rice; 2.) determine the effect on the occurrence of pests and their natural enemies in rice; 3.) compare the performance of rice in different growing seasons; and 4.) perform cost and return analysis of rice production. The study was laid out in a 3 x 3 factorial in Randomized Complete Block Design (RCBD) replicated three times with concentration levels as Factor A and brewing durations as Factor B. Treatments were applied by foliar method at weekly interval. Growth and yield data were analyzed using Analysis of Variance (ANOVA) and Latin Square Design (LSD) Tests while cost and return was determined in terms of return on investment (ROI). Results revealed that applying vermitea at 20 ml level of concentration gave the highest grain yield (3.85 tons/ha) and highest number of natural enemy insects (34.4). Brewing for 72 and 48 hours yielded most filled grains (70.00% & 68.9%, respectively) and highest grain yield (3.62 ton/ha & 3.50 ton/ha, respectively). Return on Investment is highest from treatment of 20 ml vermitea both in wet (155.12%/ha) and dry season (266.23%/ha). Brewing duration of 72 hours gave the highest ROI with 136.08%/ha during wet season and 246.67%/ha during dry season. Dry season trial showed better growth and yield performance, lower incidence of insect pest and their natural enemies to rice and higher economic returns compared to wet season. This work demonstrates that brewed vermitea is a potential attractant of beneficial insects and fertilizer for rice, which is more effective when administered in dry season.

Keywords: grain yield, growth, cropping season, foliar application, vermicompost tea

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Introduction

Rice *(Oryza sativa L.)* is the staple food in the Philippines and is an economically and politically important food crop. Despite the high demands for rice, however, rice farmers are lagged behind compared to the other countries in terms of income. This problem is attributed to the dependency of farmers on chemicals and inorganic fertilizers. Among the negative impacts of regular chemical and fertilizer use include infertility of the soil, resistance of insects to pesticide, and hazards to human health. This means that this practice do not only pose threats to production stability but also to the environment and human health (Bulalin, et al., 2016).

Efforts have been done to gradually shift the farming system into organic way to minimize environmental destruction and health hazards and promote sustainable production. Moreover, the continuous use of chemical pesticides allows the pests to develop resistance thereby the need to increase the dosage. This process does not only affect the insect pests but also the natural enemies, which are important in controlling them. Organic materials like vermicompost incorporated or surface-applied in rice soils are often promoted for improving the physical, biological, and chemical properties of soil due to the presence of readily available plant nutrients, growth enhancing substances, and a number of beneficial microorganisms like nitrogen fixing, P solubilising and cellulose decomposing organisms (Kumari and Ushakumari, 2002). Vermicompost is compost that has been digested by worms (vermi) and does not need to be turned, because worms "turn" the organic matter in their digestive tract, eliminating work for gardeners.

Vermitea, which is an extracted liquid from soaking vermicompost, can be used as an organic foliar fertilizer. The pesticidal potential of the extract needs to be tested . It is important since damage caused by insect pests has serious effects on the yield of crops. According to Beltran (2010), vermicompost and vermitea when used as fertilizer and pesticide, respectively, can increase rice productivity up to 28 percent. Brewing, aside from extracting vermitea or vermicompost teas helps microbes wake-up and multiply exponentially every 20 minutes while it takes 24 hours to make a batch of brew (Sunny Ridge Microbial Solutions, 2011). Ingham (2005) reported that the brewing time must be long enough and/or have enough mixing to extract the desired soluble nutrients (food resources used by the microorganisms and micronutrients). If brewed too long, the microorganisms may go to sleep and not be active.

Optimal level of vermitea concentration and brewing time must be established, thus this study was conducted to evaluate the growth and yield performance of rice, pest and natural enemies occurrence, and economic analysis of rice production applied with varying levels of vermitea brewed at different durations across seasons (wet and dry).

Materials and Methods

This study was conducted at the experimental area of Crop Science Research and Development Center, Capiz State University, Burias Mambusao, Capiz.

Wet season trial was conducted on June to September 2017 and dry season from November 2017 to March 2018.

Materials

The study used Certified PSB 222 rice seeds taken from the Bayer Philippines, Inc. in Iloilo City and vermitea produced from 2 kg vermicasts added with 30 L water and 1 kg molasses brewed at different times (24, 48, 72 hours) using Rex Vermi Compost Tea Brewer. The vermicasts were produced by the Organic Agriculture Project of Capiz State University in Burias, Mambusao, Capiz and the compost brewing machine was supplied by Felicidad Orchard Organic Farming, General Santos, Philippines.

Experimental Treatments and Design

This was laid out in a 3 x 4 factorial in RCBD, replicated three times. Factor A consisted of varying levels of vermi tea and Factor B different brewing durations, as indicated: Factor A [A1-10 ml, A2 – 15 ml, A3- 20 ml) and Factor B [B1 – 24 hours, B2 – 48 hours and B3 – 72 hour]. The field experiment was conducted twice; during the wet (WS) and dry (DS) seasons and the experimental treatments were replicated three (3) times.

The 748 square meters area used in the study was divided into three blocks representing the replications measuring 17 meters long and 14 meters wide and were provided with 1 meter space between blocks. Nine experimental plots measuring 4 meters wide and 4 meters long were constructed in each block with 1 meter spacing between plots.

Cultural Practices

Dikes were cleaned for a week and plots were cultivated using a hand tractor. The area was then harrowed and canals and leaves were constructed a week after. Final harrowing, levelling and field layout were done a day before transplanting. Twenty seven 4m x 5m plots were laid out in the experimental area with 1 m distance between each plot and were provided with field markings using an improvised marker. Small canals were constructed around the plot to regulate water supply.

A small paddy seedbed was prepared adjacent to the experimental area. It was thoroughly puddled and raised at approximately five (5) cm from the soil surface and was separated by a drainage canal. The seeds were sown at a rate of 50 g per square meter. Clean and healthy seeds of PSB 222 were soaked for 48 hours and were placed in a dry covered warm place. It was incubated for 72 hours then sown in the prepared seedbed. The seedlings (18-21 days) were transplanted in designated subplots with a minimum time interval between the times they are taken out from the seedbed. Single seedlings were planted carefully in straight row at a shallow depth (1-2 cm) and with a distance of 20 cm between rows and 20 cm between hills.

The water requirement for the field experiment was supplied by rainfall.

Monitoring for weeds, insect pest, and disease was made regularly. Weeds were controlled by hand pulling. No chemical pesticides were used throughout the duration of the study.

Preparation of Vermitea

The vermiteas were prepared using the 30 L capacity compost tea brewer that has a double-barrelled agitator. Two (2) kg vermicasts were filled in the agitator barrels while a kilogram of molasses and 30 liters (L) of clean water were poured in the bucket for brewing. Brewing up to the desired time such as 24, 48, and 72 hours started by plugging-in the air pumps. After the brewing is completed, the resulting liquid solution or vermitea was collected using a bottle.

Application of Vermitea

The varying levels of vermitea (10 ml, 15 ml and 20 ml) was diluted in 1 Liter of water after brewing and sprayed per plot using a knapsack sprayer. Foliar application of the treatments was done in early morning weekly from vegetative to the reproductive stage (8-15 weeks) of rice.

Data Gathering Procedure

Data on growth and yield components were taken from 10 randomly selected samples per plot. Sample plants were marked and used in obtaining other parameters. The computed grain yield, on the other hand was taken from the harvested crop cut of 5 sq. m. each plot.

Rice Growth

Plant height (cm). It was determined by measuring the distance from the base to the tip of the last leaf plant at maturity using a meter stick, expressed in centimeters.

Fresh Biomass Weight. This was determined by weighing fresh straw after removing all spikelets, expressed in grams using digital weighing scale.

Tiller count. It was determined by counting the number of tillers per plant. The mean was computed and expressed as number of tillers per hill.

Number of days from sowing/transplanting to maturity. The number of days was reckoned from the days of transplanting up to the time when 80% of the grains in the panicles have turned yellow. It was done by visual observation.

Yield and Its Components

Number of panicles. Productive panicles per hill at maturity stage were identified and counted.

Percent filled grains. It was determined by counting the number of filled grains in each panicle and was divided by the total number of grains in each panicle, expressed in percentage.

Weight of 1000-grains. 1000-grains were randomly picked and weighed using digital balance. It was corrected at 14% MC.

Computed grain yield. The grain yield was taken from the harvested crop cut of 5 sq.m. each plot. The harvested crops were threshed manually by foot trampling. Then the grains were winnowed to separate filled grains from the chaff and other undesirable materials. Digital weighing scale was used to determine grain yield weight while the grains' moisture content was determined using Kett digital moisture meter. The grain yield was expressed in tons per hectare (ton/ha) corrected at 14% moisture content.

Pests' population

The population of pests were gathered 30 days after transplanting and every morning each week (7-day interval) thereafter. Swatting of insect net 10 times for flying insects and close visual observation of all plants in the each plot for other pests and predators was done. The occurrence of pests and predators were properly recorded. Data were expressed in count per organism per plot.

Analysis of data

All sets of data gathered from the study were analyzed using the Analysis of Variance (ANOVA) and F-test using the IRRISTAR software. The significant differences among treatment means were determined using Least Significant Difference (LSD) interpreted at 5% levels of significance.

The economics of production was based on cost and return analysis and in terms of return on investment (ROI). All expenses incurred which included labor, inputs, and other miscellaneous expenses were properly recorded and were then converted into per hectare basis. The ROI was computed using the following formula:

$$\text{ROI \%} = \frac{\text{Net Income (Php)}}{\text{Total Expenses (Php)}} \times 100$$

Results and Discussion

Table 1.0. Growth and yield performance of rice as influenced by varying levels and brewing durations of vermitea.

	Growth Parameters				Yield Parameters			
	Plant Height (cm)	Mean tiller count/ hill	Biomass weight/ hill (g)	Mean no. of days to maturity	No. of panicle	Percent filled grains	1000 grains weight (g)	Grain yield (ton/ha)
A. Levels of Vermitea								
R1-10 ml	94.80	12.62	103.96	89.60	12.2	62.1	31.6	3.02c
R2-15 ml	94.76	13.00	101.19	89.70	12.1	67.8	31.8	3.37b
R3-20 ml	96.54	12.76	105.56	89.50	12.0	73.3	31.0	3.85a
B. Brewing Durations:								
B1-24 hours	95.50	13.02	104.31	90.2	9.9	64.3b	31.7	3.12b
B2-48 hours	95.32	12.58	96.81	89.5	9.5	68.9a	31.6	3.50a
B3-72 hours	95.28	12.78	105.415	89.8	9.7	70.0a	31.1	3.62a

Growth and Yield Performance

Table 1 shows the growth and yield performance of rice as affected by varying levels and brewing durations of vermitea. The varying levels of vermitea application failed to influence the growth parameters of rice. However, foliar application of 20 ml of vermitea produced the highest yield (3.85 ton/ha) among other treatments. The grain yield of rice increased as the levels of brewed vermitea used was increased. This implies that the brewed vermitea is more effective when applied to rice plants at higher level of concentration. The application of varying levels of vermitea has affected the grain yield but not the other yield parameters. The data however, is the best indicator of the effect of using vermitea in rice, which differs to the findings of Fritz and Franke-Whittle, et al (2012), which states that there is no effects of (compost) tea application on plant yield.

Plants applied with vermiteas brewed for 72 hours and 48 hours obtained more filled grains (70.0% and 68.9%, respectively) and higher grain yield (3.62 ton/ha and 3.5 ton/ha, respectively) than those sprayed with vermitea brewed for 24 hours with 64.3% filled grains and 3.12 ton/ha grain yield. There was an increase in the percentage of filled grains and grain yield as the brewing duration is increased from 24 hours to 48 hours. This conforms to the report of Rex Compost Tea Brewer (2009) that the more soluble materials were extracted or the more foods for the beneficial bacteria and fungi the longer the brewing time. Therefore, more nutrients were available to the plants. However, brewing vermitea for 72 hours gave comparable rice yield performance to 48 hours. It implies than applying vermitea brewed longer than 48 hours will not result to significant increase in the yield. The same report by Rex Compost Tea Brewer (2009) stated that there should be optimal time for tea production to attain balance between extracted and growth of organisms. Longer brewing time will make organisms to use up all their food and go to sleep and/or may colonize the surface of containers and begin to develop anaerobic layers on the container walls.

Table 2.0. Occurrence of pests and their natural enemies in rice as influenced by varying levels and brewing durations of vermitea.

Treatment	Pest Occurrence	
	Insect Pests	Natural Enemies
A.Levels of Vermicompost Tea		
R1-10 ml	71.9	24.8b
R2-15 ml	66.8	28.1b
R3-20 ml	57.0	34.4a
B.Brewing Durations		
B1-24 hours	69.6	30.4
B2-48 hours	63.7	28.7
B3-72 hours	62.3	28.1

Occurrence of insect pest and their natural enemies

Data on the pest occurrence as affected by varying levels and brewing durations of vermitea is shown in Table 2. Applying vermitea at varying levels did not significantly affect the number of insect pests in rice. Nevertheless, green leaf hopper (Nephottix spp.) was the most dominant insect pest followed by black bug (Scotinophtera spp). Other species observed were greenhorned caterpillar (Mycalesis sp.), leaf folder (Cnaphalocrocis medinalis), green grasshopper (Oxya hyla intricate), short-horned grasshopper (Oxya hyla intricate), leaf folder - larva (Cnaphalocrocis medinalis), whorl maggot (Hydrellia philippina), and rice bug (Leptocorisa oratorius). Moreover, varying levels of vermitea applied influenced the occurrence of natural enemies. The highest number of natural enemy insects was recorded from plants applied with 20 ml vermitea (34.4). This means that increasing the levels of vermitea application does not harm but even attracts the beneficial insects and arthropods in rice. Natural enemies observed were species of orange-tail damselfly (Agriocnemis pygmaea), orange beetle/lady beetle (Cycloneda sanguine L.), orb spider (Argiope catenulata) and lynx spider (Oxyopes javanus).

Brewing vermiteas at different durations had no significant effect on the occurrence of insect pests and natural enemies in rice. This implies that the effect of vermitea on incidence of insect pests and natural enemies is the same regardless of length of time of brewing.

Table 3.0. Performance of rice and pest and natural enemies occurrence at different seasons as influenced by varying levels and brewing durations of vermitea.

Cropping Seasons	Growth Parameters: Plant height	Growth Parameters: Mean tiller count/ hill	Growth Parameters: Biomass weight/ hill (g)	Growth Parameters: Mean no.of days to maturity	Yield Parameters: No. of Panicle	Yield Parameters: Percent filled grains	Yield Parameters: 1000 grain/ ha	Yield Parameters: grains yield/ ha	Occurrence of pest & their natural enemies: No. of insect pest	Occurrence of pest & their natural enemies: No. of natural enemies
Wet Season	88.60b	10.81b	84.61b	90.11	7.31a	65.32b	28.69b	2.27b	78.0b	38.67a
Dry Season	102.13a	14.77a	122.52a	89.50	12.10b	70.09a	34.19a	4.56a	65.2a	19.52b

Comparison of rice performance in terms of growth, yield, and pest and natural enemies occurrence during wet and dry seasons is shown in table 3. The experimental plants exhibited better growth performance in plant height (102.13 cm), mean tiller count per hill (14.77) and biomass weight per hill (122.52 ton/ha) during dry season trial. The mean number of days to maturity is the same for the two growing season. Higher values in yield parameters such as percent filled grains (70.09) and 1000-grain weight (34.19 g) was recorded during dry season. The range in grain yield is between 2.27 and 4.56 ton/ha in favor of dry season. Among the yield parameters only the number of panicle (7.31) was recorded higher during wet season. The occurrence of insect pests was lesser when the varying levels of vermitea brewed at different durations were applied during dry season than during wet season. The same trend is found in the occurrence of natural enemies.

The result above indicates that applying brewed vermitea is more effective in suppressing insect pests and increasing yield during dry season of production.

Economic Analysis

Economics of production is the major consideration of farmers for adopting technology. Thus, cost and return analysis of rice (PSB 222) production at different seasons as influenced by varying levels of vermitea brewed at different durations is presented in Table 4.

Table 4.0. Cost and return analysis of rice production at different seasons as influenced by varying levels and brewing durations of vermitea.

Treatment	Cost of Production (PhP/ha)		Net Income (PhP/ha)		Return on Investment (%/ha)	
	Wet	Dry	Wet	Dry	Wet	Dry
A.Levels of Vermitea						
10 ml	21,867	23,067	11,916	45,989	107.55	199.35
15 ml	22,242	23,442	16,070	52,788	130.16	225.16
20 ml	22,618	23,818	20,888	63,426	155.12	266.23
B.Brewing Durations						
24 hours	22,185	23,385	12,963	47,671	122.35	203.64
48 hours	22,242	23,442	16,816	56,452	134.41	240.44
72 hours	22,300	23,500	19,095	58,079	136.08	246.67

Cost of production. Application of 10 ml incurred the lowest production cost of Php21,867.00/ha for wet season and Php23,067.00/ha for dry season. This is attributed to the least amount thereby lowest cost of vermitea diluted per application. Similarly, shortest time of brewing (24 hours) incurred the lowest production cost of Php22,185.00/ha (wet season) and Php23,385.00/ha (dry season). The result is expected as shorter time of brewing requires lesser cost for use of power and labor employed.

Net income. Highest net income was realized from plants applied with 20 ml vermitea with Php20,888.00/ha for wet season and Php 63,426.00/ha for dry season. Brewing to 72 hours also gave the highest net income of Php19,095.00/ha and Php58,079.00/ha for wet and dry season, respectively. Applying the highest level and longest brewing of vermitea earned the highest net income despite of incurring the highest cost of production among treatments. The result is attributed to the grain yield obtained from 20 ml application and 72 hours brewing duration. The income from sale of rice was based on prevailing buying price data of the National Food Authority of Php17/kg.

Return on investment. Based on the computed costs and net incomes, the highest Return on Investment (ROI) was recorded from treatment of 20 ml vermitea both in wet and dry season at 155.12%/ha and 266.23%/ha, respectively. On the other hand, brewing duration of 72 hours gave the highest ROI with 136.08%/ha during wet season and 246.67%/ha during dry season. The high grain yield and the income derived from the sales are the contributing factor to the to ROI. The results further revealed that the returns per hectare were higher on dry season production compared to that of wet season in all treatments.

Conclusions

The varying levels and brewing durations of vermitea failed to influence the growth performance of rice. However, application of 20 ml of vermitea and brewing for 48 and 72 hours produced the highest yield among other treatments. Increasing trend in yield is found as level of vermitea application is increased. The different vermitea levels did not significantly affect the number of insect pests in rice but applying at 20 ml recorded the highest number of their natural enemies. The experimental plants exhibited better performance in most growth and yield parameters such as plant height, mean tiller count per hill, biomass weight per hill, and grain yield during dry season production. The incidence of pests and their natural enemies is also fewer during the dry season. Moreover, highest grain yield from using 20 ml level of vermitea and 72 hours brewing duration lead to highest net income and ROI per hectare of rice production. Therefore, higher rate of vermitea application and longer time of brewing generates more yield and attracts natural enemy insects and arthropods in rice. Using vermitea in rice production is more effective and profitable in dry season.

Recommendations

Based on the results of the study, it is recommended to apply 20 ml vermitea and brew to 72 hours to enhance the yield of rice thereby increasing net income and Return on Investment (ROI). Application of 20 ml vermitea to attract beneficial insects and arthropods in rice is also recommended. Increase the level of vermitea application to determine the optimum level by which it can enhance the yield and incidence of beneficial insects. Lower values are found on wet season, thus the need to look into the rate and frequency of application on the next study. A similar study using different vermicompost sources will be practical to test the effectiveness of different materials in suppressing of insect and attracting their natural enemies.

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