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Effectiveness of fermented rice bran with coconut water on the growth and yield of pechay

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Abstract

Biofertilizers are becoming more popular these days since consumers have become more conscious of the food they harvest and eat. The study assessed the effectiveness of fermented rice bran on the growth and yield of pechay as fertilizer. Fermented rice bran is made up of the following mixed substrates: Rice bran (kg), Coconut water (gal), Brown sugar as substitute of molasses (tbsp) with the following level of concentrations: Control (T1), 250ml/L of water (T2), 500ml/L of water (T3), and 1,000ml/L of water (T4) which are applied in the two variety of pechay: Black Behi (V1) and Pavito (V2). Fermented liquid produced is a biofertilizer which involves microorganisms such as bacteria and fungi that help in the availability of essential macronutrients and improve plant absorption in the leaves and soil. Based on the study, the increase in growth and yield parameters are attributed greatly to the fermented rice bran level of concentrations and the variety of pechay. The highest significant effect, correlation, and cost and return analysis among parameters are obtained when applied with 500ml/L of water (T3). This is followed by 250ml/ L of water (T2), 1,000ml/ L of water (T4), and Control (T1). Likewise, other research findings, biofertilizer like fermented rice bran can be an economic, environmental-friendly, and effective source of nutrients for crops like pechay, because it utilizes agricultural waste as substrates for biofertilizer production.

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Introduction

There is a strong emphasis on sustainable agriculture around the world. This is based on the pillars of quality and yield with minimum environmental damage. However, the widespread use of fertilizers, particularly in developing countries, causes negative effects such as reducing the quality of products, increase the cost of fertilizer, destruction of desirable microorganisms, and irreparable damage to the soil structure. Because of these problems, governments and environmental organizations look for new ways to manage and use of these wastes. (Pourzamani, Hamidreza, Ghavi, Mohammad, 2016). One method to solve problems is making biofertilizer through the process of fermentation (Chojnacka, Moustakas and Witek-Krowiak, 2020, Kumari 2019).

Biofertilizers can be expected to reduce the use of chemical fertilizers and pesticides. The microorganisms in biofertilizers restore the soil's natural nutrient cycle and build soil organic matter. Using biofertilizers, healthy plants can be grown, while enhancing the sustainability and the health of the soil (Becero *et al.,* 2014 and Chojnacka *et al.,* 2020). Microorganisms play several roles, a preferred scientific term for such beneficial bacteria is plant-growth promoting rhizobacteria (PGPR).

Biofertilizer source can be food waste (FW) which contains 70% of organic matter typically dispose of into landfills and agro-industrial byproducts, waste, or residue like bagasse, mature coconut water, molasses, leaves, stem, stalk, peel, seed pods, cobs, rice bran, husk, straw, and others which have health harmful effects when disposed improperly. Because of these problems, governments and environmental organizations look for new ways to manage and use of these byproducts and wastes (Pourzamani and Ghavi, 2016).

Rice bran is one of the most abundant and locally available agricultural wastes which contains variable ingredients such as carbohydrate that maybe used as a carbon and energy source for the growth of fungi in the production of single cell protein such as *Aspergillus niger*. Rice bran supplemented with minerals such as sucrose encourages the growth of *A. niger* to produce single cell protein (Oshoma, & Ikenebomeh, 2015). Therefore, they are extremely advantageous in enriching soil fertility and fulfilling plant nutrient requirements by supplying the organic nutrients through natural means. Bio-fertilizers are much preferred over other fertilizers as they do not contain any chemicals which are harmful to the living soil (Devi & Sumathy, 2018).

Studies conducted by researchers were done on the effectiveness of fermented organic fertilizers such as fish bones and onion plants (Jang and Kuk, 2020) . In 2015, Jesu (2015) conducted a study on rice bran in comparion with other organic fertilizers like wood ash and poultry manure. On the other hand, the study of Santosa and Soekendarsi (2018) focused on rice and coconut water waste and found to provide promising results in enhancing the productivity of leafy vegetables like cabbage and pechay. However, no study yet had been conducted on the effectiveness of fermented rice bran added with coconut water to various crops. In this experiment, the liquid biofertilizer was formulated using the different media, such as rice bran, coconut water, and molasses. Through fermentation process, liquid biofertilizer was produced and applied in different levels of concentrations to variety of pechay to determine its growth and yield response.

Materials and methods

Variety

Black Behi (*Brassica rapa* L.) has a maturity period of 25-30 days with dark green leaves and petioles and is grown year-round. It is fast growing with uniform maturity and with long succulent tender petioles. Pavito Pechay has a maturity period of 25 days. It has dark green leaves. It is high yielding and an early variety. A favorite variety among farmers, hotels, and restaurants.

Soil Preparation, Sampling, and Analysis

Prior to soil preparation, soil sampling was done randomly in the experimental area. Collected soil samples were weighed (about 1kg) and air-dried and then thoroughly mixed, place in plastic bags and brought to the Provincial Soils Laboratory at San Fernando, Pampanga for analysis.

Soil Preparation

Land was tilled and pulverized through rotavator with a four-wheel tractor and raised through grab-hoe and flatten with rake. The field experiment was prepared by making six inches raised bed covered with plastic mulch. Plastic mulch was used to eliminate growth of weeds that will compete for plant nutrition.

Seed Preparation

The seed varieties were bought from the agricultural supply and were soaked in ¼ inch deep in seed tray with friable and loose soil such as clay loam.

Seed Sowing and Transplanting

In a matter of 3-4 days after sowing, the seeds germinated. Then, after 2-3 weeks when several leaves were developed, seedlings were transplanted individually in the six inches raised bed covered with plastic mulch in 6 inch-plant distance and 12 inch-distance between rows.

Irrigation

Black Behi (*Brassica rapa* L.) and Pavito Hybrid was irrigated every other day using sprinkler depending on the weather condition.

Preparation and Application of
Fermented Rice Bran Preparation
Materials:

3kg. of Rice bran	Cloth	Stirrer
30 Gal. of Coconut water	Rubber band	
2kg. of Brown sugar	Weighing instruments	
	Plastic container/drum Pail	

Procedure

1. The 3kg. of rice bran and 30 Gal. of coconut water were mixed in a pail.
2. Ninety (90) tablespoons of brown sugar (substitute for molasses) to obtain a ratio of 3: 30: 90 was added.
3. The three (3) substrates were stirred for about 15-20 minutes in the drum or container.
4. The container/ drum lid was left open for 24 hours to encourage the bacteria and fungi accumulate on the substrates.
5. After 24 hours, the lid was closed with a cloth fit snugly on the tip of the drum using rubber band.
6. The drum was kept on a cool dry place away from the direct heat of the sun so that the bacteria will not be killed due to the heat of the sunlight.
7. The substrate was stirred every twice a week to speed up fermentation process.
8. After sixty (60) days, the substrate was applied.

Fertilizer Application

Application of basal fertilizer following the recommended rate of 20 bags per hectare or 0.4 kilograms/ per plot for the field experiment was done before transplanting. This is to provide nutrients and ensure plants survival before treatment application.

The fermented rice bran varies in different application wherein Control (T1) received no application, 250ml for T2, 500ml for T3, and 1,000ml for T4. Each of this fermented rice bran is diluted to 1 L of water. Control (T1) is necessary to compare each treatment's effect on the growth and yield of pechay.

After 2 days from transplanting of Black Behi and Pavito pechay, fermented rice bran as fertilizer is applied as foliar application. This liquid biofertilizer will be applied early morning or late in the afternoon for effective application. The application will be done in weekly interval. This will continue until 3-4 days before harvesting.

Cultivation, Weeds, Pests, and Disease Control

The field experiment was fence with bamboo poles enclosed with nets to avoid entrance of stray animals that might destroy the crops present on the raised beds.

Since the raised bed have plastic mulch, weeds were manually uprooted every 2-3 weeks or when there is existence of weeds. After 2 days from transplanting, spraying of organic pesticides like Kakawati or Madre de Cacao leaves extract blended with chili extract 500 grams for every 1 liter of water was necessary to eliminate insect pests like army worms, looper, aphids and other insect-eating leaves. This was followed regularly after 3 weeks and stop at 2 or 3 days before harvesting. During heavy infestation occurs, application of commercial pesticide can be necessary eliminate pest like army worm, aphids, cutworms, and other insects.

Harvesting

Black Behi and Pavito pechay were harvested manually 30 days after transplanting by cutting its stem using knife or shear.

Research Design

The experiment was arranged in a 2 x 4 factorial experiment in Split-Plot design with three replicates for each treatment. There were two main factors which are varieties of pechay: Black Behi (V1) and Pavito (V2) and four levels of fermented rice bran as fertilizers: Control (T1), 250ml/L of water (T2), 500ml/ L of water (T3), and 1,000ml/L of water (T4). The study assessed the effectiveness of fermented rice bran on the growth and yield of the peachy as fertilizer.

Experimental Design and Lay-out

In 2 x 4 factorial experiment in Split-Plot design with (3) replications, the treatments were arranged within each block or replication with the variety as main plot and levels of fermented rice bran as sub plot. The main plot has two raised beds measuring one by four (1 x 4) meters where the two varieties of peachy were transplanted in alternate succession across replications. Then, each of the two varieties were randomly assigned with treatment as sub plot using draw lots and labeled with different levels of fermented rice bran.

The following are the treatments in the field experiment:

Two varieties of pechay:

V1= Black Behi Pechay and V2= Pavito Pechay

Four fermented rice bran plus coconut water with molasses:

T1= Control, T2= 250ml/ L of water,

T3= 500ml/ L of water, and

T4= 1,000ml/1 L of water

This experiment was conducted at Malabon, Candelaria Zambales in a garden with an area of 525sq. m. or 0.0525ha with clay-loam soil. The clay-loam garden soil is very much preferred because the plants grow easily. This location has an average annual rainfall and a deep well as water source with water pump. There is earthen canal near and along the plots.

Location

Fig. 3. Map of Brgy. Malabon, Candelaria Zambales where the experiment was conducted.

Data Analysis

The following statistical tools were used in the analysis of data and in the interpretation of results:

Weighted Mean. This was determined by getting the total number and divided by the number of treatments. The weighted mean is a single value that describes the set of observations on the measured variables.

Analysis of Variance. All the data gathered was tabulated and statistically analyze using Analysis of Variance (ANOVA) two-factorial in Split-Plot design.

Comparison and Treatment Mean

Least Square Difference (LSD) test was used to determine the comparison between each treatment in replications.

Duncan's Multiple Range Test (DMRT) DMRT is used in the computation of numerical boundaries that allow for the classification of the difference between any two treatment means as significant or non-significant.

Correlation Analysis

Multiple Correlation analysis provides a measure of the degree of association between the variables or the goodness of fit of a prescribed relationship to the data at hand.

Pearson's Correlation Coefficient (r) is a measure of the strength of the association between the two variables.

t-Test is use to test statistic that is calculated from the sample to compare sample to the null hypothesis. If the test statistic is extreme enough, this indicates that the data are so incompatible with the null hypothesis that can reject the null.

Results

Effect of Fermented Rice Bran on the Growth of Pechay

As shown in Table1, the increase in the number of leaves varies from different levels of fermented rice bran applications. Among fermented rice bran level of applications, 500ml of fermented rice bran / L of water shows high significant effects in Black Behi (V1) which increases with 10.25 than Pavito (V2) with 10.17 number of leaves, while Control (T1) has the least effects. As compared with 250ml/ l of water (T2) and 500ml/ l of water (T3), the application of 1,000ml/ L of water (T4) in Black Behi with an increase of 9.08 and Pavito with 9.00 shows a decrease on trend in the number of leaves. The decrease in the number of leaves in 1, 000ml/ L of water (T4) means negative effect and therefore, less effective.

The width of leaves of two pechay varieties grown with four levels of fermented rice bran, it shows that among the four levels of fermented rice bran, 500ml of fermented rice bran / L of water (T3) has the greatest increase in width of leaves (cm). Black Behi (V1) with 12.42cm has the greater response than Pavito (V2) with 12.25cm increase in the width of leaves (cm) at week 5. There is also a significant increase in the width of leaves (cm) when applied with 250ml/ L of water (T2) and 1, 000ml/ L of water (T4). In contrast, the width of leaves (cm) of pechay applied with of 1, 000ml/ L of water (T4) decreased as compared with 500ml/ L of water (T3) and 250ml/ L of water (T2) effects. Therefore, higher level of fermented rice bran can negatively affect the width of leaves (cm).

Both the increase of 13.33cm in plant height in Black Behi (V1) and 13.25cm in Pavito (V2) were applied with 500ml of fermented rice bran/ L of water (T3). This level of fermented rice bran has the highest significant effects as compared with the other levels on the plant height (cm) of the two varieties of pechay at week 5. In addition, 250ml/ L of water (T2) and 1, 000ml/ L of water have significantly increased the plant height (cm) of the two varieties of pechay as compared to the effect of Control (T1). In comparison with 500ml/ L of water (T3) and 250ml/ L of water (T2), the application of 1,000ml/ L of water (T4) decreases the plant height (cm). Therefore, the higher the level of fermented rice bran (1,000ml/ L of water) decreases the plant height (cm) which incurs negative effects.

The application of fermented rice bran has significant effects on the growth of pechay as compared with Control (T1), although its effects vary from different levels of applications. In Black Behi (V1) with 15cm and Pavito with 14.92 increased in leaf length (cm) at week 5 is applied with 500ml/ L of water (T3) which shows high significant effects. In comparison with the effects of 500ml/ L of water (T3), 250ml/ L of water (T2) and 1,000ml/ L of water (T4), it is evident that there is a decrease on the leaf length (cm) in T4 in the leaf length (cm) of two varieties of pechay. The decrease on the leaf length (cm) in 1,000ml/ L of water (T4) implies a negative effect.

The Duncan's Multiple Range Test (DMRT) shows that the effect of 250ml/ L of water (T2) and 500ml/ L of water (T3) treatments on the number of leaves at week 5 in Black Behi (V1) and Pavito (V2) pechay has no significant difference at 5% level of significance. This means that the number of leaves at week 5 between the two fermented rice bran treatments has very little significant difference. Meanwhile, 1,000ml/ L of water (T4) and Control (T1) are significantly different at 5% level of significance in both varieties of pechay. This means that the two fermented rice bran as treatment has greater significant difference on the number of leaves in both varieties of pechay.

The effects between the four fermented rice bran treatments namely: Control (T1), 250ml/ L of water (T2), 500ml/L of water (T3), and 1, 000ml/ L of water (T4) using Duncan's Multiple Range Test (DMRT) show that the four levels of fermented rice bran as treatment is significantly different at 5% level of significance. This means that the width of leaves (cm) between the four fermented rice bran treatments in the two varieties of pechay at week 5 has greater significant difference.

Based on the Duncan's Multiple Range Test (DMRT), it shows that the effect of 1,000ml/L of water (T4) and Control (T1) in the plant height (cm) of Black Behi (V1) is not significantly different at 5% level of significance. This means that the two fermented rice bran as treatment has very little significant difference on plant height at week 5, while the plant height (cm) of the two varieties of pechay in Pavito (V2) is significantly different at 5% level of significance. Meanwhile, 500ml/L of water (T3) and 250ml/L of water (T2) is significantly different at 5% level of significance. This means that the plant height (cm) of the two fermented rice bran as treatment at week 5 has greater significant difference.

Table 1. Duncan's Multiple Range Test on the Growth Parameters for Two Pechay Varieties Applied with Four Fermented Rice Bran Treatments at Week 5.

Black Behi (V1)	Growth Parameters of Pechay			
	Number of leaves[e]	Width of leaves (cm)[e]	Plant Height (cm)[e]	Leaf length (cm)[e]
Control (T1-no fermented rice bran)	8.50[c]	9.50[c]	11.00[c]	12.00[d]
250ml fermented rice bran /L of water (T2)	10.00[a]	11.50[b]	12.42[b]	14.08[b]
500ml fermented rice bran /L of water (T3)	10.25[a]	12.42[a]	13.33[a]	15.00[a]
1,000ml fermented rice bran /L of water (T4)	9.08[b]	10.42[d]	11.67[c]	13.33[c]
Pavito (V2)				
Control (T1-no fermented rice bran)	8.50[c]	9.58[d]	11.00[b]	11.92[d]
250ml fermented rice bran /L of water (T2)	9.92[a]	11.42[b]	12.25[b]	14.08[b]
500ml fermented rice bran /L of water (T3)	10.17[a]	12.25[a]	13.25[a]	14.92[a]
1,000ml fermented rice bran /L of water (T4)	9.00[b]	10.42[c]	11.58[b]	13.17[c]

[e]Average of three replications

[f]Any two means having a common letter are not significantly different at the 5% level of significance.

The leaf length (cm) of the four fermented rice bran as treatment namely: Control (T1), 250ml/L of water (T2), 500ml/L of water (T3), and 1, 000ml/L of water (T4) is significantly different at 5% level of significance. This means that between the four fermented rice bran effects on the leaf length (cm) of Black Behi (V1) and Pavito (V2) pechay at week 5 has greater significant difference.

The study of Szilvia, Döme, Szilvia , Gábor , Ibolya , Miklós , Péter , Szilvia , Tarek and Bákonyi (2020) indicated that fermented alfalfa BJ significantly increased the content of photosynthetic pigments (chl a and chl b), relative chlorophyll (SPAD value), lengths of stem and root, fresh masses of stem, root, and leaves, volumes of stem and root, and leaf area. Application of fermented rice bran significantly improved the number of leaves, width of leaves, plant height, and leaf length of the two varieties of pechay. The decrease in the number of leaves in 1, 000ml/L of water (T4) means negative effect and therefore, less effective. The study of [8] lettuce applied with organic fertilizers have significantly longer and wider leaves, higher shoot, and lower concentrations of nitrate. The highest effect is when applied with 500ml/L of water (T3) followed by 250ml/L of water (T2), and 1,000ml/L of water as compared to Control (T1).

Effect of Fermented Rice Bran on the Yield of Pechay

As shown on the data on Table 2, Black Behi (V1) shows the greater response on the average weight (g) than Pavito (V2) even applied with the same levels of fermented rice bran. This means that Black Behi responds more effectively when applied with fermented rice bran as fertilizer than Pavito (V2).

It is noted that among the four levels of fermented rice bran as fertilizer, 500ml/L of water (T3) applied in Black Behi (V1) with average weight of 76.64 g and Pavito (V2) with 74.54 g has the highest average weight (g) followed by 250ml/L of water (T2), 1,000ml/L of water (T4), and Control (T1). This means that T3 is the most effective fermented rice bran level of application to increase the average weight (g) of pechay. Meanwhile, the decrease in the average weight (g) of pechay applied with 1, 000ml/L of water (T4) as compared to 500ml/L of water (T3) and 250ml/L of water (T2) implies a negative effect on the average weight (g) of pechay.

The average yield (g/m²) of two varieties of pechay increased significantly when applied with fermented rice bran as fertilizer as compared with Control (T1). In the two varieties of pechay, Black Behi (V1) shows greater response on the average yield (g/m²) than Pavito (V2) even applied with the same levels of fermented rice bran, while the application of 500ml/ L of water (T3) of fermented rice bran generated the greatest effects on the two varieties of pechay. The effect from 250ml/L of water (T2) to 500ml/L of water (T3) increases, while in 1,000ml/L of water (T4) the average yield (g/m²) begins to decrease. This means that higher level of fermented rice bran as fertilizers incur negative effects on the two varieties of pechay.

Variety Black Behi (V1) showed greater response on the average yield (g/plot) than Pavito (V2) even applied with the same levels of fermented rice bran. Meanwhile, the application of fermented rice bran as fertilizer shows highest significant effects when applied with 500ml/ L of water (T3) with average yield of 1786.70 g/plot in Black Behi (V1) and 1816.00 g/ plot in Pavito (V2). There are also significant effects in average yield when applied with 250ml/ L of water (T2) and 1,000ml/ L of water (T4) in comparison to Control (T1). In comparison with the effects in 500ml/ L of water (T3) and 250ml/ L of water (T2), the average yield (g/plot) decreased when applied with 1,00ml/ L of water (T4). This means that higher level of fermented rice bran application can incur negative effect on the average yield (g/plot) of pechay.

The Duncan's Multiple Range Test (DMRT) shows that the average weight (g/plant) of Black Behi (V1) in four fermented rice bran treatments namely: Control (T1), 250ml/L of water (T2), 500ml/L of water (T3), and 1, 000ml/L of water (T4) has significant difference at 5% level of significance. This means that the four fermented rice bran treatment has greater significant difference on average weight (g/plant) of Black Behi (V1) and Pavito (V2) at week 5. Meanwhile, Control (T1) and 1, 000ml/L of water (T4) in Pavito (V2) has no significant difference at 5% level of significance. This means that the difference between the two fermented rice bran treatments has very little significance; while between 250ml/L of water and 500ml/ L of water (T3) it shows that it has greater significance on the average weight (g/plant) of Black Behi (V1) and Pavito (V2) at week 5.

Table 2. Duncan's Multiple Range Test[e] for Comparing Average Weight (g/plant) among Four Fermented Rice Bran Treatments for Two Pechay Varieties.

Black Behi (V1)	Average Weight[f] (g/plant)	Average Yield[f] (g/m²)	Average Yield[f] (g/plot)
Control (T1-no fermented rice bran)	56.58[d]	282.57[d]	1130.33[d]
250ml fermented rice bran /L of water (T2)	66.55[b]	295.40[b]	1312.83[b]
500ml fermented rice bran /L of water (T3)	76.64[a]	452.97[a]	1786.70[a]
1,000 m fermented rice bran L/L of water (T4)	58.16[c]	287.33[c]	1165.00[c]
Pavito (V2)			
Control (T1)	56.50[c]	282.40[d]	1129.67[d]
250 m fermented rice bran L/L of water (T2)	64.78[b]	292.70[b]	1257.40[b]
500ml fermented rice bran /L of water (T3)	74.54[a]	454.00[a]	1816.00[a]
1,000ml fermented rice bran /L of water (T4)	57.21[c]	286.23[c]	1144.83[c]

[e]Average of three replications
[f]Any two means having a common letter are not significantly different at the 5% level of significance

Duncan's Multiple Range Test (DMRT) shows that the average yield (g/m²) of Black Behi (V1) and Pavito (V2) applied with four fermented rice bran treatments has significant difference at 5% level of significance. This means that there is greater significant difference between the four fermented rice bran treatments on average yield (g/m²) of Black Behi (V1) and Pavito (V2). Pechay applied with the highest level of fermented rice bran resulted to the highest yield in both varieties.

Significant differences at 5% level of significance on the effect of four fermented rice bran treatment in the average yield (g/plot) of Black Behi (V1) and Pavito (V2) was found. This means that there is greater significant difference between the four fermented rice bran treatments on the average yield (g/plot) of Black Behi (V1) and Pavito (V2).

Relationship Between Growth and Yield Parameters of Pechay

Number of Leaves and Yield Parameters

Table 3 shows relationship using the t-computed value on number of leaves to average weight (g/plant) with 5.624 and average yield (g/plot) with 3.238 are greater than the t-tabular value of 2.477. Meanwhile, the Pearson-r on number of leaves to average weight (g/plant) of 0.917 and to average yield (g/plot) of 0.798 has positive relationship. Therefore, there is a significant relationship at 5% level of significance. On the other hand, the relationship of number of leaves to average yield (g/m²) with t-computed value of 2.374 is less than the t-tabular value of 2.477 shows non-significant effect, while the Pearson-r of 0.798 has positive relationship. This means that there is a decreased relationship between number of leaves to average yield (g/m²). Generally, the relationship shows that the increase in number of leaves also increases the yield parameters.

Table 3. Relationship between Growth and Yield Parameters.

Growth Parameters	Yield Parameters	Pearson-r	t computed	t tabular
Number of Leaves	Average Weight (g/ plant	0.917*	5.624	2.447
	Average Yield (g/m²)	0.798ns	2.374	2.447
	Average Yield (g/plot)	0.798*	3.238	2.447
Width of Leaves (cm)	Average Weight (g/ plant	0.955*	7.911	2.447
	Average Yield (g/m²)	0.877*	3.261	2.447
	Average Yield (g/plot)	0.877*	4.463	2.447
Plant Height (cm)	Average Weight (g/ plant	0.976*	10.939	2.447
	Average Yield (g/m²)	0.925*	4.163	2.447
	Average Yield (g/plot)	0.925*	5.977	2.447
Leaf Length	Average Weight (g/ plant	0.916*	5.597	2.447
	Average Yield (g/m²)	0.840*	2.907	2.447
	Average Yield (g/plot)	0.840*	3.790	2.447

* Significant at alpha=0.05

ns Non-significant

Width of Leaves and Yield Parameters

As shown on the table 3, the relationship using t-computed value on the width of leaves to average weight (g/plant) with 7.911, average yield (g/m²) with 3.261, and average yield (g/plot) with 4.463. The data show greater t-computed than the t-tabular value of 2.477, while the Pearson-r on width of leaves to average weight (g/plant) of 0.955 and 0.877 to both average yield (g/m²) and average yield (g/plot) show positive relationship. Therefore, the increase in the width of leaves also increases the yield parameters. Thus, the relationship of width of leaves to the yield parameters is significantly different at 5% level of significance.

Plant Height and Yield Parameters

In the relationship of the width of leaves to average weight (g/ plant) with 10.939, average yield (g/m²) with 4.163, and average yield (g/ plot) of 5.977, it shows that t-computed is greater than t-tabular value of 2.447. Meanwhile, the Pearson-r on plant height to average weight (g/plant) with 0.976, while 0.925 to both average yield (g/m²) and average yield (g/plot) have shown positive relationship. Therefore, the increase in plant height also increases the yield parameters. Thus, the relationship of plant height to the yield parameters is significant at 5% level of significance.

Leaf Length and Yield Parameters

The relationship between leaf length to average weight (g/plant) with of 5.597, average yield (g/m²) with 2.907, and average yield (g/plot) with 3.790 shows that the t-computed is greater than the t-tabular value. Meanwhile, the Pearson-r on the relationship of leaf length to average weight (g/plant) with 0.916 and 0.840 to both average yield (g/m²) and average yield (g/plot) have shown positive relationship. Therefore, the increase in leaf length also increases the yield parameters. Thus, the relationship of leaf length to the yield parameters is significant at 5% level of significance.

Discussion

In terms of growth **t**he application of rice bran and compost as biofertilizer in a ratio of 1:3 was the optimum formulation to promote the growth in terms of plant height, leaf surface area, number of leaves,

dry and fresh weight of pechay plant (Nurfalah, Atika, Ayuningrum, Nadia, and Affandi, Muhammad Ramadhan, 2019). The experiment conducted by Vedasto, Abayon, Romaquin and Relingo (2015) showed that application of different biofertilizers significantly affected the plant height, leaf length, and width of leaves and number of days from transplanting to harvesting of pechay. The higher the concentration of the fermented rice bran the effect on growth performance was also higher. The survey of An, Young, Jeong, Yong, Yeon, Hyeong, Sang, Kwang and Byung (2014) indicated that the use of fermented liquid fertilizer promoted growth of agricultural crops. In this study the effect of fermented rice bran on the growth parameters of pechay shows significant difference at 5% level of significance.

In terms of yield, the application of 500ml/L of water resulted in the highest average yield of pechay in black Behi and Pavito., but the different biofertilizer applied to pechay did not significantly affect the number of marketable plants, while those fertilized with biofertilizer from Fruit Wastes (FW) + Indigenous Microorganism (IMO) produced significantly higher yield which is comparable to Commercial Biofertilizer (CB) (6,200kg/ha) used as check. The increase in yield is due to the cost-effective and efficient as biofertilizer to pechay.

This study confirms the findings of Romero, Lopez, Porciuncula and Juico (2016) that the application of fermented plant and seed extracts had the highest computed yield of 12t/ha which is 47% higher than the yield obtained in commercial fertilizer and 106% higher than the control. In the study conducted by Pascual, Carabio, Rondina, Abello, & Pascual, (2020) the application of fermented seaweed improved the growth performance of lettuce. Meanwhile, the relationship between the growth and yield parameters to the four fermented rice bran treatments also shows significance at 5% level of significance. In the study conducted by Pascual, Carabio, Rondina, Abello, & Pascual, (2020) the application of fermented seaweed improved the growth performance of lettuce. The results of the study conducted by Apzani , Wardhana, Sunantra, Baharuddin, & Arifin (2017) showed that liquid organic fertilizer extracted from water hyacinth was effective in improving the growth of lettuce plants.

Conclusion

Generally, fermented rice bran is an effective fertilizer based on the increased on the growth and yield parameters compare to control (no fertilizer). This means that application of fermented rice bran can be a cheaper and easy to produce fertilizer especially for the farmers who engage in organic farming practices. This study can improve their production of pechay.

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