

Formulation and Testing of Combined Organic Liquid Supplement from *Trichoderma spp.* and Fermented Plant and Seed Extracts on the Growth of Organic Pechay

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ABSTRACT

The Ramon Magsaysay Center for Agricultural Resources and Environment Studies (RM-CARES) has isolated *Trichoderma longibrachiatum* and *Trichoderma asperellum* from carabao manure. Since *Trichoderma* is mass produced in solid form and applied basally, the conversion of *Trichoderma* into liquid form allows the supply of nutrients at different growth stages of crops.

This study aimed to formulate and test the efficacy of combined organic liquid supplement (OLS) from *Trichoderma spp.* and fermented extracts from kakawate and malunggay leaves, banana fruits, soybean and mungbean seeds. Based on the results for one trial on pechay, undertaken in a certified organic area at the Ramon Magsaysay Center for Agricultural Resources (RM-CARES), Central Luzon State University Science City of Muñoz (CLSU), Nueva Ecija, yield was significantly increased by the supplementation of *Trichoderma spp.* in combination with fermented plant and seed extracts. Treatment with 1:0.5 ratio of *T. asperellum* : fermented plant and seed extracts significantly gave the highest computed yield of 12 t/ha which is 47% higher than the yield obtained in commercial OLS and 106% higher than the control. The treatment with 1:0.5 ratio of *T. longibrachiatum* : fermented plant and seed extracts, and treatment with commercial OLS produced comparable yield with 9.80 t/ha and 8.17 t/ha, respectively. Since the developed OLS from *Trichoderma* and fermented plant and seeds extracts is at par or even surpassed the yield of commercial OLS, it has the potential as bio-liquid fertilizer for organic pechay production which could be possibly substituted to commercial OLS.

Keywords: organic liquid supplement, *Trichoderma longibrachiatum*, *Trichoderma asperellum*, fermented extracts, bio-fertilizer, commercial OLS

INTRODUCTION

The use of *Trichoderma* is a well-documented technology that involves the interaction of *Trichoderma* strains with the plant that promotes growth, improves

crop yield, increase nutrient availability and enhance disease resistance (Harman *et al.*, 2004; Benítez *et al.*, 2004). The Ramon Magsaysay Center for Agricultural Resources and Environment Studies (RM-CARES) has isolated *Trichoderma longibrachiatum* and *Trichoderma asperellum* from carabao manure. Since *Trichoderma* is mass produced in solid form and applied basally, the conversion of *Trichoderma* into liquid form allows the supply of nutrients at different growth stages of crops. Addition of organic nitrogen and bio-fertilizer will have beneficial effects in increasing population of soil microorganisms, specifically in the surface layer at root rhizosphere, that produce substances which stimulate plant growth (Awad, *et al.*, 1993).

On the other hand, pechay (*Brassica chinensis*), a leafy vegetable in the Philippines which is usually eaten as salad vegetable or in combination with other foods contains several nutrients like Vitamin A, Vitamin C, Folate, Thiamine, Riboflavin and Vitamin B-6 and as an antioxidants. Though this vegetable is packed with health promoting goodness, this is undesirable if grown using chemical pesticides because it can suppress the immune system. As cited by Repetto and Baliga (1996), epidemiologic evidence of an association between pesticide exposure and increased incidence of human disease, particularly those diseases to which immunocompromised individuals are especially prone. Likewise, organic liquid fertilizers provide plants with high concentrations of easily-absorbed, soluble nutrients, thereby enhancing their health and productivity. Also, it is easy to prepare, with readily available biological materials, it is organic, low cost, improve yield, suppress pest and disease, enhance soil texture, structure and fertility (Krawczyk, 2016). Also, as cited by Sopha and Uhan (2013), liquid organic fertilizers application leads to faster nutrient supply than compact organic fertilizers do (Rohmiyat *et al.*, 2006). Research work done by Martin (2004), showed that 396 grams of fruits per plant from hot pepper plants applied with Sagana 100 bio-organic fertilizer at the rate of 2.0 t/ha was found significantly higher than the yield produced by the control plants and those plants applied with Sagana 100 at the rate of 1.0 and 1.5 tons. On the other hand, the degradation of the soil's physical, chemical and biological properties that lead to the gradual destruction of our ecology has been associated with the long term use of chemical fertilizer and pesticides (Jirapornchareon, 1993). Thus, the development and establishment of organic liquid supplement (OLS) from *Trichoderma* (with components of plant and seed extracts) for pechay production needs to be evaluated. Hence, the objective of this study was to develop *Trichoderma*-based organic liquid supplement and evaluate its efficiency in pechay production. Specifically, it aims to determine the highest yield of pechay as a result of OLS from *Trichoderma spp.* in combination with different plant and seed extracts.

MATERIALS AND METHODS

Formulation of OLS from two Trichoderma spp. and Fermented Extracts

Rice bran and soil mixture with ratio of 1:1 was the substrate used as growing media for *Trichoderma longibrachiatum* and *Trichoderma asperellum* isolated by RM-CARES. Fifty grams of the growing media were placed in polypropylene bag tied with rubber band and sterilized at 15 psi at 121 °C for 15 minutes then allowed to

cool and inoculated with pure culture of *T. longibrachiatum* and *T. asperellum* and incubated for one week. Then, 1 liter sterilized water with 100 g of sterilized molasses was added in each of the prepared media and growth were observed for a week. This served as the stock solution where 100 ml of this was further diluted to 1 liter of water. The fermented extracts from kakawate leaves, banana fruits, mungbean and soybean seeds were developed through the Organic Fertilizers and Microbials for Improved Soil Fertility for Organic Vegetable Production Project, with a total NPK content of 3.22%. This was used, using 50 ml of the fermented extracts/liter of water.

Preparation of the Different Extracts

Collection and preparation of leaves and seeds for fermentation. Fresh leaves of kakawate, ipil-ipil and malunggay leaves were collected at RM-CARES farm where these plants are abundantly growing. Soybean and mungbean seeds were produced by RM-CARES while banana fruits were bought in the market.

Seed extraction and fermentation. The washed seeds were soaked in water overnight at a ratio of 1:5 seed to water. Water was removed in the morning and the soaked material was blended and transferred in a clay pot. Molasses was added at a ratio of 1:1. The mixture was covered with Manila paper and allowed to ferment for 7 days after which, the liquid part of the extracted seeds was decanted in a container and the juice was strained with a fine cloth to collect the crude extract (that will serve as the stock solution) and then was placed in dark bottles and labeled with the name of the crude extract and the date of extraction.

Crude leaf extract and fermentation. The washed leaves were chopped into pieces and were pounded using mortar and pestle. Molasses was added and mixed to the pounded materials at a ratio of 1:1 by weight basis. The mixture was transferred in a clay pot covered with paper and was fermented for 7 days, then the juice was squeezed and strained with a fine cloth. The crude extract collected served as the stock solution and stored in dark bottles, labeled with the name of the extract and the date of extraction.

Preparation of mixture extracts. Fermented kakawate, banana, malunggay, ipil-ipil, soybean and mungbean extracts were mixed at a ratio of 1 part of the mixture: 1 part of water and sprayed as indicated in the treatments.

Pot Experiment on the Use of OLS from Fermented Plant and Seed Extracts Alone or in Combination with Trichoderma spp.

Seeds of Black Behi pechay were sown in plastic tray. The 120 polyethylene bags (10 x10 cm) were filled with a mixture of 8 kg soil and 80 g RM-CARES organic fertilizer. After two weeks, pechay seedlings were transplanted in polyethylene bags at one seedling per bag. Each plant was drenched with 100 ml of organic liquid supplement from *T. longibrachiatum* and *T. asperellum*. Commercial organic liquid fertilizer at the rate of 150 ml/16 L of water was drenched weekly to the plant. Daily watering was done starting at 2 DAT to two days before harvest. The following were the treatments evaluated: T1 – Control; T2 – Commercial OLS (check); T3 – 20 ml OLS from fermented plant and seed extracts; T4 – 50 g of *T. longibrachiatum* + 100g molasses; T5 – 50 g of *T. asperellum* + 100g molasses; T6 –

1:1 (*T. longibrachiatum*: fermented plant and seed extracts) and T7 – 1:1 (*T. asperellum*: fermented plant and seed extracts). Cultural management practices in this experiment were the same for all the pot experiment done.

The experimental set up for pot experiment can be seen in Figure 1.



Figure 1. Experimental set-up for pot experiment of pechay.

Testing of the High Performing OLS from Trichoderma spp. and Fermented Plant and Seed Extracts on Organic Pechay Production

The combination of OLS from *Trichoderma spp.* and different fermented plant and seed extracts that produced the highest yield of pechay was further tested based on the performance of the crop using lower and higher ratio of 1:1. The treatments used were as follows: T1 – Control; T2 – Commercial OLS; T3 - 1:0.5 (*T. longibrachiatum*: fermented seed and plant extracts); T4 - 1:1 (*T. longibrachiatum*: fermented seed and plant extracts); T5 – 0.5:1 (*T. longibrachiatum*: fermented seed and plant extracts); T6 - 1:0.5 (*T. asperellum*: fermented seed and plant extracts); T7 - 1:1 (*T. asperellum*: fermented seed and plant extracts) and T8 – 0.5:1 (*T. asperellum*: fermented seed and plant extracts). Cultural management practices in this experiment were the same in the experiment done in the performance of OLS from fermented plant and seed extracts alone or in combination with *Trichoderma spp.*

The data gathered were: 1) plant height (cm); 2) number of leaves; 3) diameter of leaves (cm); and 4) yield (g).

Efficacy Testing

A fully converted organic area was used in this study. It was previously a rice-vegetable area using conventional farming until its conversion to organic in 2011. The conversion process entails the gradual reduction of inorganic inputs and subsequent combination with organic inputs until use of 100% organic inputs and methods. The initial soil analysis of the area prior to the start of the experiment had a pH of 5.23, organic matter of 1.86%, total N of 0.08%, available P of 21.4 ppm and exchangeable K of 170.0 ppm. Blocks of 2 x 25 meters were prepared. Each block was subdivided into four plots measuring 2 x 5 m with a distance of 1 m between plots (Figure 2). The following treatments were used:

- T1 – Control
- T2 – Commercial OLS (check)
- T3 – 1:0.5 OLS (*T. longibrachiatum*: fermented plant and seed extracts)
- T4 – 1:0.5 OLS (*T. asperellum*: fermented plant and seed extracts)

RM-CARES organic fertilizer (OF) was applied basally on each treatment at the rate of 10 t/ha before sowing. Seeds of Black Behi were sown at the rate of 2 grams per plot at a distance of 20 cm between rows. Drenching of 100 ml OLS was done weekly. Commercial OLS at the rate of 100ml/16L of water was sprayed weekly.

The crops were watered at saturated condition using a sprinkler after seeding. Watering was done daily until the seeds emerged and then every two days, if there was no rain or as the need arose until two days before harvesting.

Weekly hand pulling of weeds was done to prevent competition for nutrients, water, sunlight and other environmental factors that affect the growth and development of the plants. Cultivation in between plants was done at 14 days after transplanting (DAT) for better soil aeration and better root growth.

Insect pests were identified and monitoring of their population and the extent of their damage for pechay was done at 7 DAE to 28 DAE. Incidence of diseases on pechay was also monitored from seedling to vegetative stage. To control insect pests, hot pepper fruit extract was sprayed weekly at the rate of 50 ml stock solution/li of water.

The data gathered were: 1) number of marketable plants/plot; 2) number of non-marketable plants/plot; 3) weight of marketable plants (kg); 4) weight of non-marketable plants (kg); 5) yield per plot (kg); 6) computed yield (t/ha); and 7) reaction to insect pests and diseases.



Figure 2. Experimental set-up for field experiment of pechay.

Data Analysis

Data gathered were analyzed using Complete Randomized Design (CRD) for pot experiment and Randomized Complete Block Design (RCBD) for efficacy testing. Comparison among means was done using Duncan's Multiple Range Test (DMRT).

RESULTS AND DISCUSSION

Growth of Trichoderma spp. on Media Used and Preparation of Trichoderma-based Stock Solution

Visual observation on the growth of two *Trichoderma spp.* was done one week after inoculation. As shown in Figure 3, a positive response on the growth of both *Trichoderma spp.* was observed in which *T. longibrachiatum* showed a light green powdery colony (Figure 3a) while rapid growing greenish powdery colony was observed in *T. asperellum* (Figure 3b) on the prepared solution with molasses. This served as the stock solution where 100 ml of this was further diluted to 1 liter of water that resulted to a tea-like color appearance. The growth of the two *Trichoderma spp.* in the stock solution is necessary to become effective as bio-fertilizer. As mentioned by Maheshwari *et al.*, 2008, *Trichoderma spp.* is widely used in agriculture and industry and isolates of *T. reesei* are used as bio-pesticides and bio-fertilizers. It is due to the fact that propagules of fungus can be produced cheaply and in large quantity both in liquid and dry formulations and stored for months. Also, the large amounts of biomass containing mycelia, chlamydospores, and some conidia were produced in the liquid media using molasses and brewers yeast within 5 days. Likewise, in the study conducted by Khan *et al.*, (2005), they prepared mass culture of bio-agent fungus *T. harzianum* as bio-pesticide using sawdust-soil + 5% molasses moisture (15:1:1) whereas, immobilization (carrier) was prepared in fly-ash soil + 5% molasses which was found superior than other formulations in the market.



Figure 3. Growth of *T. longibrachiatum* (a) and *T. asperellum* (b) in prepared solution with molasses.

Performance of Pechay as Affected by Application of Fermented Plant and Seed Extracts Alone or in Combination with Trichoderma spp.

As shown in Table 1, a significant difference on plant height was obtained with the application of the different treatments. Tallest plant was observed in treatments applied with 1:1 ratio of *T. asperellum* in combination with fermented plant and seed extracts (T7) but comparable with the rest of the *Trichoderma spp.* treated plants. Smallest plant was observed in control plants (T1) with 19.80 cm.

No significant variation on the number of leaves was obtained on the different treatments evaluated, which ranged from 7-8 leaves per plant.

The 1:1 ratio of both *T. longibrachiatum* and *T. asperellum* in combination with

fermented plant and seed extracts produced the widest leaf width with 9.87 cm (T6) and 10.43 cm (T7), respectively, although comparable with the diameter of plants applied with commercial OLS (T2) with 9.65cm.

Table 1. Agronomic and yield components of pechay as affected by the application of fermented plant and seed extracts alone or in combination with *Trichoderma spp.*

Treatment	Plant Height (cm)	Number of Leaves	Diameter of Leaves (cm)	Yield (g) (10 Plants)
T1 – Control	19.80b	7	8.93c	258.33d
T2 – Commercial OLS (check)	20.97b	7	9.65abc	300.00cd
T3 – 20 ml OLS from fermented plant and seed extracts	21.17b	7	9.33bc	280.00cd
T4 – 50 g <i>T. longibrachiatum</i> + 100g molasses	21.50ab	8	9.30bc	318.33c
T5 – 50 g <i>T. asperellum</i> + 100g molasses	21.40ab	8	9.58bc	376.67b
T6 – 1:1 OLS (<i>T. longibrachiatum</i> + fermented plant and seed extracts)	21.60ab	8	9.87ab	395.00ab
T7 – 1:1 OLS (<i>T. asperellum</i> + fermented plant and seed extracts)	23.13a	8	10.43a	438.33a

Means in each column having similar letters are not significantly different at 5% level by DMRT

Highly significant differences were observed in yield of pechay as affected by the application of *Trichoderma spp.* alone or in combination with fermented plant and seed extracts, similar with treatments applied with 1:1 ratio of *T. longibrachiatum* and *T. asperellum*: fermented plant and seed extracts (T6 and T7). Highest yield (per 10 plants) was obtained from plants in treatments applied with 1:1 ratio of *T. longibrachiatum* : fermented plant and seed extracts (T7) with 438.33 g which is 31.33% higher than the plants treated with commercial OLS (T2) and the lowest was in the control (T1) with 258.33 g. All the *Trichoderma spp.* treatments when combined with fermented plant and seed extracts produced higher yields.

Evaluation of the High Performing OLS from Trichoderma spp. and Fermented Plant and Seed Extracts on Organic Pechay Production

Presented on Table 2 are the different agronomic and yield parameters of pechay as affected by the application of the different ratio of *Trichoderma spp.* in combination with fermented plant and seed extracts. Significant differences on plant height were obtained wherein the tallest plants were observed in treatments applied with commercial OLS (T2) at 20.83 cm which was comparable with 1:0.5 ratio of *T. asperellum* : fermented plant and seed extracts (T3) followed by plant height of the rest of *Trichoderma spp.* : fermented plant and seed extracts treatments. However, insignificant number of leaves was counted on all the treatments. On the other hand, width of leaves ranged from 8.85 cm to 10.25 cm with the widest leaves of plants from commercial OLS (T2) with 11.13 cm which is comparable with 1:0.5 OLS (*T. longibrachiatum* : fermented plant and seed extracts) (T3) with 10.25 cm leaf width.

Yield of treatments with commercial OLS (T2) significantly produced the highest yield (per 10 plants) with 325 g although comparable with yield in treatments having a ratio of 1:0.5 and 1:1 *T. longibrachiatum* or *T. asperellum* : fermented plant and seed extracts, indicating that the two *Trichoderma spp.* with fermented plant and seed extracts can be substituted with the commercial OLS using the ratio of 1:0.5.

Table 2. Agronomic and yield components of pechay as affected by the application of different ratio of organic liquid supplement from *Trichoderma spp.* and fermented plant and seed extracts.

Treatment	Plant Height (cm)	Number of Leaves	Diameter of Leaves (cm)	Yield (g) (10 plants)
T1 – Control	17.41c	7	8.85c	180.00d
T2 – Commercial OLS (check)	20.83a	7	11.13a	325.00a
T3 – 1:0.5 OLS (<i>T. longibrachiatum</i> + fermented plant and seed extracts)	20.60a	7	10.25ab	318.33ab
T4 – 1:1 OLS (<i>T. longibrachiatum</i> + fermented plant and seed extracts)	19.35b	7	9.90b	298.33ab
T5 – 0.5:1 OLS (<i>T. longibrachiatum</i> + fermented plant and seed extracts)	19.32b	7	9.30bc	250.00c
T6 – 1:0.5 OLS (<i>T. asperellum</i> + fermented plant and seed extracts)	19.25b	7	9.67bc	285.00abc
T7 – 1:1 OLS (<i>T. asperellum</i> + fermented plant and seed extracts)	19.38b	7	9.90b	286.67abc
T8 – 0.5:1 (<i>T. asperellum</i> + fermented plant and seed extracts)	19.23b	7	9.50bc	280.00bc

Means in each column having similar letters are not significantly different at 5% level by DMRT

Efficacy Test of Formulated Combined OLS from Trichoderma spp. and Fermented Plant and Seed Extracts on the Growth of Organic Pechay

The treatments with 1:0.5 OLS ratio (*T. asperellum* : fermented plant and seed extracts, T4) produced plants with the highest number of marketable plants which is significantly higher from that of the application of commercial OLS (T2) and 1:0.5 OLS (*T. longibrachiatum* : fermented plant and seed extracts, T3) with total plant counts of 74 and 69, respectively. The least with 59 marketable plants were recorded from the control (T1).

As seen in Table 3, supplementation of 1:0.5 OLS (*T. asperellum* : fermented plant and seed extracts, T4) significantly increased the weight of marketable plants per m² with 1.23 kg. Drenching of 1:0.5 OLS (*T. longibrachiatum* : fermented plant and seed extracts, T3) produced marketable plants with 0.93 kg which is 75% higher over the control but comparable with plants in treatments applied with commercial OLS (T2).

Table 3. Yield and yield components of pechay (t/ha) as affected by the application of organic liquid supplement from *Trichoderma spp.* in combination with fermented plant and seed extracts.

Treatment	Number of Marketable Plants/ m ²	Weight of Marketable Plants/ m ² (kg)	Number of Non-Marketable Plants/m ²	Weight of Non-Marketable Plants/m ² (kg)	Computed Yield (t/ha)
T1 – Control	59c	0.53c	20a	0.09	5.83c
T2 – Commercial OLS (check)	84a	0.87b	15b	0.10	8.17b
T3 – 1:0.5 OLS (<i>T. longibrachiatum</i> + fermented plant and seed extracts)	69b	0.93b	8b	0.09	9.80ab
T4 – 1:0.5 OLS (<i>T. asperellum</i> + fermented plant and seed extracts)	74b	1.23a	6b	0.10	12.00a

Means in each column followed by a common letter are not significantly different at 5% level by DMRT

Significant difference was obtained on the number of non-marketable plants in which control (T1) produced the highest with 20 plants, while similar results were obtained in plants in treatments applied with commercial OLS (T2), 1:0.5 OLS (*T. longibrachiatum* : fermented plant and seed extracts, T3) and 1 :0.5 OLS (*T. asperellum* : fermented plant and seed extracts, T4) with 8, 8 and 6, respectively.

Insignificant difference was obtained on the weight of non-marketable plants of pechay. Commercial OLS (T2) and 1:0.5 OLS (*T. asperellum* : fermented plant and seed extracts, T4) produced numerically the highest non-marketable plants with 0.10 kg followed by 1:0.5 OLS (*T. longibrachiatum* : fermented plant and seed extracts, T3) and control (T1) both with 0.9 kg weight.

The yield was significantly increased by the supplementation of *Trichoderma spp.* in combination with fermented plant and seed extracts. Treatments applied with 1:0.5 OLS (*T. asperellum* : fermented plant and seed extracts, T4) significantly produced the highest computed yield with 12 t/ha or 47% higher from commercial OLS (T2) and 106% higher from the control (T1). Treatments applied with 1:0.5 OLS (*T. longibrachiatum* : fermented plant and seed extracts, T3), and commercial OLS (T2) produced comparable computed yield with 9.80 t/ha and 8.17 t/ha, respectively.

Since the developed OLS from *Trichoderma spp* in combination with plant and seed extracts surpassed the yield obtained from commercial OLS (T2), it could be possibly substituted to commercial OLS. Aside from the health and environment benefits that can be derived from developed OLS from *Trichoderma spp* in combination with plant and seed extracts, substitution of it to commercial organic liquid fertilizer could be one of the cost cutting measures in pechay production because the materials to be used in the production of these are locally available and can be easily prepared by the farmers. Moreover, the significant yield increase could be attributed to the capacity of *Trichoderma* in releasing a variety of compounds that induce systemic resistance against soil borne pathogen, and enhances crop productivity (Harman, 2000). Furthermore, the biological mechanism of *Trichoderma* may be due to multiple factors as they have the ability to produce a variety of extracellular lytic enzymes and different metabolites (as cited by Lopez *et al.*, 2015). Also, fermented plant extracts also improve soil fertility, control pests and diseases and increase microbial diversity and ecology (Pascual, *et al.*, 2013).

Reaction to Insect Pests and Diseases

Whiteflies (*Bemesia tabaci* G.) and aphids (*Aphis gossypii* G.) were observed on pechay from 7 to 28 DAE and with very small weekly increase averaging less than 5 per plant (Figure 4 and 5). Control showed the highest number of whiteflies per 10 plants while the lowest number was observed in application of 1:05 OLS (*T. longibrachiatum* : fermented plant and seed extracts). This slow increase in population of the insect pests can be attributed to the ability of the organic inputs to minimize or control insects hence, population of whiteflies and aphids in all treatments during the growing period of pechay are at minimum range and not able to cause economic damage to the plants. This is supported by the research findings of Abadilla (1982) that crops fertilized with organic matter have greater plant resistance to pest and diseases. It could be that the whiteflies and aphids are

present but not damaging the plants. Also, the spraying of hot pepper extract interfered with their growth and development. The study conducted by Dela Cruz *et al.* (2007) showed that application of different botanical extracts significantly suppresses the population of aphids in crops like melon. Moreover, whiteflies and squash beetle population failed to build-up with spraying of botanical extracts.

Diseases

No disease was monitored in all the treatments evaluated in the entire duration of the study which could be attributed to the ability of the *Trichoderma* to suppress plants diseases. As cited by Lopez, *et al.*, 2014, *Trichoderma* species have been long recognized as agents for the control of plant disease (Harman *et al.*, 2004). Among the various isolates of *Trichoderma*, *T. viridae*, *T. harzianum*, *T. virens* and *T. hamatum* are used against the management of various diseases of crop plants especially with soil borne pathogens (Samuels, 2006). Further, the organic matter content of the soil in each treatment is enough to develop a certain measure or degree of resistance against common diseases of leafy vegetables like pechay. As cited by Cooperband, 2002, a soil rich in organic matter and regularly supplied with different kinds of soil organic matter will support a rich and varied population of soil organisms. Organic matter provides a carbon source for primary producers like cyanobacteria that can convert atmospheric nitrogen to plant available N forms. A soil populated by a diverse, active microbial population is less likely to support uncontrolled spread of plant pathogens (Cook and Baker, 1983). Interactions between beneficial soil organisms and plant pathogens create situations in which pathogens are suppressed or inhibited, especially soil-borne pathogens. Some soil microorganisms are antagonistic to plant pathogens, creating an unfavorable environment for them to grow. Others compete against pathogens, effectively keeping the pathogen population in check. Also, research studies show that moderate application rates (5-10 tons/acre) of organic amendments (both raw and composted) can reduce the incidence and severity of root rot diseases like Pythium.

CONCLUSION

The effect of *Trichoderma longibrachiatum* and *Trichoderma asperellum* as organic liquid supplement applied weekly to pechay significantly increased the yield of pechay when combined with fermented plant and seeds extracts because of the regular supply of nutrients during the growth of the crop. Since the developed OLS from *Trichoderma* and fermented plant and seeds extracts is at par or even surpassed the yield of commercial OLS, it has the potential as bio-liquid fertilizer for organic pechay production which could be possibly substituted to commercial OLS. Aside from the health and environment benefits that can be derived from developed OLS from *Trichoderma spp* in combination with plant and seed extracts, substitution of it to commercial organic liquid fertilizer could be one of the cost cutting measures in pechay production because the materials to be used in the production of these are locally available and can be easily prepared by the farmers.

RECOMMENDATIONS

Determine the micro nutrient components and growth regulators/hormones of developed OLS. Re-evaluate the potential of the developed OLS and test to other crops.

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