

## Characteristics of Farms Undergoing Conversion to Organic as Affected by Organic Fertilizer and Fish Emulsion Application

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### ABSTRACT

The application of 20t/ha OF in each treatment supplemented with FE, in different frequencies of application resulted to higher yield as compared with control. Also, continued application of solid organic fertilizer in the soil, markedly improved all the soil properties after each cropping. Labor cost in land preparation and weeding were also reduced in different treatments with 20 t/ha + FE frequency. FE supplementation to organic solid fertilizer relatively reduced insect pest population and incidence of diseases.

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### Introduction

The conventional farming method using synthetic chemicals account for most farming today. Although yields have significantly increased by adopting this system, there are trade-offs that the farmers and environment have had to bear as a consequence of keeping up with this development. The improper usage of fertilizers more than the recommended amounts causes formation, build-up and concentration of mineral salts of fertilizers which leads to compaction layer and soil degradation in the long-term. High compaction decreases porosity and aeration while increasing bulk density and soil penetration resistance. Moreover, root development and plant growth will be limited by reducing water and nutrient uptake which decreases yields (Massah and Azadegan, 2016). Because of this, farmers who have realized the negative impact of using synthetic chemicals have decided to shift to organic farming which relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with opposing effects. Although, yields were lower during the conversion period of conventional to organic farming, a yield increase and improved soil properties will be realized in the latter years due to repeated application of organic amendments. Van-Camp et al. (2004) found that organic amendments influence soil characteristics by the interdependent change of biological, chemical and physical properties. to apply a style (in this case, italic) in addition to the style provided by the drop down menu to differentiate the head from the text.

Organic fertilizers (OF) is an amendment that contain both macro and micro elements that improve plant growth and development. It is usually a byproduct or end product of a naturally occurring process. It enhances the natural soil processes, which have long-term effects on soil fertility (Singh, 2012). Crops yield increased by up to 250% due to long-term applications of high rates of municipal solid waste compost (Diacono and Montemurro, 2009). However, since

organic fertilizer contains low level of nutrients, they are applied in larger amount than conventional fertilizer to obtain the same nutrient value. Hence, it is necessary to add liquid fertilizer as supplement to complete the nutrient requirement of the crop.

Fish emulsion (FE) is liquid fertilizer obtained from the by-products of fish oil and fish meal which increases yield due to its higher nitrogen content of 5% (Vanderlinden, 2009). El-Tarabily et al., (2003), evaluated commercial fish emulsion as a plant growth medium and as a nutrient base to enhance radish (*Raphanus sativus* L.) growth by bacterial and actinomycete isolates. It was found to support plant growth in a sandy soil as effectively as an applied inorganic fertilizer. Likewise, foliar sprays of a mixture of fish emulsion and bacteria were used to control moths (Wyatt and McGourty, 1990), and dilute solutions of fish emulsion could control bacterial spot (*Xanthomonas vesicatoria*) of tomato and pepper (Abbasi et al., 2003). Thus, the study aimed to determine the response of crops as well as changes in soil physical and chemical properties of farms undergoing conversion to organic system.

### Materials and Methods

The area under conversion to organic farming for three years was used in this study. Permanent blocks of 2.5 x 1.5 m were prepared in which each block was divided into four plots measuring 1m x 7.25 m with a distance of 0.5 m between plots.

Data in each study were analyzed following the analysis of variance (ANOVA) for a Randomized Complete Block Design (RCBD) with three replications.

The following treatments were used:

T1 – 20t/ha OF

T2 – 20t/ha OF + FE applied every two weeks

T3 – 20 t/ha OF + FE applied once a week

T4 – 20t/ha OF + FE applied twice a week

### Cultural Management for each Crop

**Pechay:** Seeds of Black Behi were sown at the rate of two grams per plot at a distance of 20 cm between rows.

**Eggplant:** Twenty-five day old seedlings of Casino variety were transplanted in a row in each plot with a distance of 0.50 m between hills and on a row with a total of 15 plants/plot.

RM-CARES organic fertilizer (OF) has an analysis of 1.5% total N, matter, 2.5% total P and 2.5% total K and 32% organic matter while fish emulsion (FE) has an analysis of 5% total N, 2% total P, and 2% total K.

The OF was applied as basal at the rate of 20 t/ha before planting/transplanting of each crop. Fish emulsion was diluted to 1L:4500L which resulted to a pH of 5.78 and 2 ds/cm EC and these were applied for each treatment.

Weekly handpulling of weeds was done after counting the number of weeds present in the area. The weeds were removed to prevent competition for nutrients, water, sunlight and other environmental factors that affect the growth and development of plants. Cultivation in between plants was done at 14 days after transplanting (DAT) for better soil aeration and better root growth.

Insect pests of the crops under study were identified and monitoring of their population and the extent of their damage for each crop was done at seven DAE to 28 DAE for pechay and seven DAT to 82 DAT for eggplant.

To control insect pests, hot pepper fruit extract was sprayed weekly at the rate of 50 ml stock solution/li of water.

Incidence of diseases on pechay was monitored from seedling to vegetative stage. For eggplant, diseases were monitored from plant emergence to fruiting stage. The pathogens were identified based on their manifested symptoms on the plants and signs of the organisms.

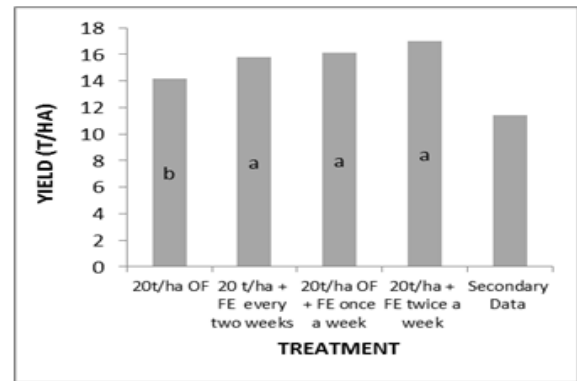
### Results and Discussion

#### Yield Performance of Pechay and Eggplant

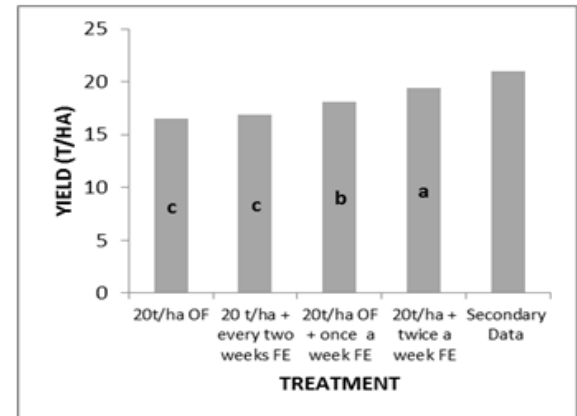
The applications of different organic inputs like OF and FE to crops is necessary to improve its growth and development. Figure 1 and 2 presents the yield of pechay and eggplant (t/ha) as affected by the application of OF and FE.

In pechay, it can be noted that supplementation of FE as foliar treatment irrespective of the frequency of application increased the yield of pechay as compared to application of 20 t/ha OF alone. FE applied twice every two weeks produced 1.62 t/ha or 11.41 percent increase and FE applied once a week produced 1.92 t/ha or 13.52 percent increase from that of OF alone. On the other hand, application of 20 t/ha OF with FE twice a week had increased the yield of pechay by 2.83 t/ha or 19.93 percent having the highest yield of pechay with 17.03 t/ha among the treatments evaluated. This coincides with the study of Aganon et al., 2009 that addition of FE resulted in a greater increase in the weight of different crops evaluated. Likewise, Abassi et al., 2006 found out that that application of 1% FE significantly increased total potato tuber yield by 41% to 170% in nine soils, compared with the control treatments. Likewise, an increase of 5.63 t/ha or 49.39 % was obtained as compared with the secondary data with 11.4 t/ha during the previous conversion period (Figure 1a).

In terms of eggplant, plants applied with 20 t/ha OF with FE twice a week produced the highest computed yield with 2.8 t/ha (17%) followed by OF + FE once a week with 1.4 t/ha (8.4%) over the OF alone. However, FE applied every two weeks failed to show differences on the computed yield t/ha with OF alone. Likewise, a yield decrease of 1.6 t/ha was obtained as compared with the previous conversion period with 21 t/ha, respectively (Figure 1b).

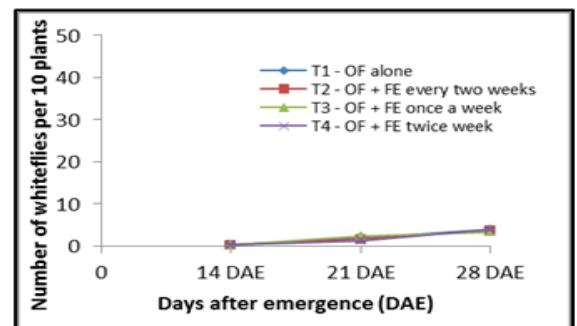


(a)

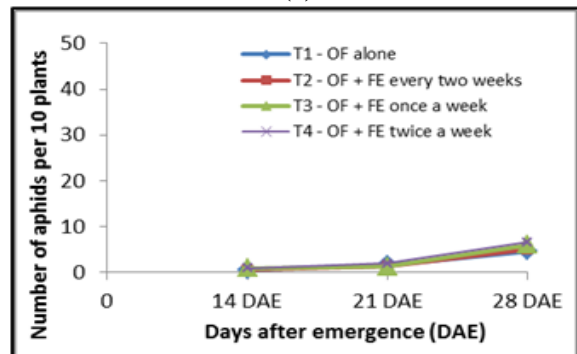


(b)

Figure 1. Yield of a) pechay (t/ha) and b) eggplant as affected by the application of OF and FE



(a)



(b)

Figure 2. Population of a) whiteflies (*Bemesia tabaci* G.) and b) aphids (*Aphis gossypii* G.) on pechay at 14 to 28 DAE

Supplementation of solid OF with FE is very important so that farmers with farm undergoing conversion to organic farming will not suffer tremendous yield loss during the process of conversion. Application of FE augmented the nutrients released slowly from solid OF since the nutrient

available in FE is high. In the process of farm conversion to organic, generally the yield of any crop will decline, due to the reduction in the available major nutrients in the soil. Hence, it is very important that during the process of conversion, the use of organic fertilizer must be supplemented with foliar spray such as FE or its equivalent organic foliar fertilizer.

#### Changes in Soil Properties of the Experimental Field Under Conversion to Organic

Soil is a mixture of organic matter, minerals, gases, liquids, and organisms that gives life. Thus, because of tremendous uses of synthetic chemicals, a need to revitalize these soils with practices such as addition of organic amendment (Magdoff and Weil, 2004) is necessary. In this study, repeated application of organic fertilizer obviously improved all the soil properties after each cropping (Table 1). From an initial soil analysis with a low nutrient content, an increase of 133.33% for total N, 76.47% in organic matter, 47.57% in available P and 49.41% in exchangeable K. The bulk density of 1.60 g/cc before the conversion from conventional to organic farm gradually declined to 1.34 g/cc or a decrease of 0.26 g/cc. The repeated application of composted materials enhances soil organic nitrogen content, storing it for mineralization in future cropping seasons, often without inducing nitrate leaching to groundwater. Likewise, long-lasting application of organic amendments increased organic carbon by up to 90% versus unfertilized soil, and up to 100% versus chemical fertilizer treatments. Also, regular addition of organic residues, particularly the composted ones, increased soil physical fertility, mainly by improving aggregate stability and decreasing soil bulk density (Diacono and Montemurro, 2009).

**Table 1. Changes in soil characteristics after each cropping on the conversion of conventional farm to organic farm.**

Soil Properties	Before Conversion	Year of Conversion to Organic			Analysis after 3 years
		1 <sup>st</sup> year	2 <sup>nd</sup> year	3 <sup>rd</sup> year	
Total N (%)	0.03	0.05	0.05	0.07	+0.04 (133.33%)
Organic Matter (%)	0.68	1.00	1.04	1.20	+0.52 (76.47%)
Available P (ppm)	10.30	12.0	14.0	15.2	+4.90 (47.57%)
Exchangeable K (ppm)	9.31	11.0	12.7	13.9	+4.60 (49.41%)
pH	5.48	6.24	6.52	6.54	+1.06 (19.34%)
Bulk Density (g/cc)	1.60	1.51	1.40	1.34	-0.26 (19.43%)

#### Changes in Land Preparation and Weeding Cost in Farm Under Conversion to Organic

The bulk density of the soil in the area at the start of the conversion period (1<sup>st</sup> year) with 1.60g/cc was compact and gradually transformed into a more porous structure after the last cropping with 1.34g/cc (3<sup>rd</sup> year). The improvement in bulk density of the soil brought about by the continued application of solid organic fertilizer, decreased the cost of labor in land preparation and weeding because of easier land preparation and faster uprooting of weeds. For conventional farms, the highly compacted soil, need repeated hoeing to make the soil loose. Weed roots and vegetative parts left on the ground during weeding; later become the source of weeds.

Before the start of conversion, land preparation for a 37.5 sq.m area amounted to PhP78.00 but was reduced to PhP22.00

for 0.70 hr (Table 2). The 5.63 hrs of weeding at the start of conversion dropped to 2.25 hrs at the last cropping with reductions of 72% and 60% for land preparation and weeding, respectively. The 140 t/ha solid organic fertilizer applied in three years conversion is enough to significantly reduce the land preparation and weeding with increased soil rejuvenation.

**Table 2. Changes in land preparation and weeding cost and man-hr per 37.5 m<sup>2</sup> with application of OF and FE for three years.**

Farm Activity	Economic Parameters (37.5 m <sup>2</sup> )	Cost Before Conversion (PhP)	Year of Conversion to Organic		
			1 <sup>st</sup> year	2 <sup>nd</sup> year	3 <sup>rd</sup> year
Land prep	Man-hours	2.50	2.30	1.07	0.70
	Cost @ PhP 250/day	78.00*	72.00*	33.00*	22.00*
Weeding	Man-hours	5.63	4.60	2.67	2.25
	Cost @ PhP 250/day	176.00	144.00	83.00	70.00

\*Land preparation is done by hoeing

#### Occurrence of Insect Pests in the Experimental Field Under Conversion to Organic Farm

Whiteflies (*Bemisia tabaci* G.) and aphids (*Aphis gossypi* G.) (Figure 8a and 8b) were observed on pechay from 14 to 28 DAE and with very small weekly increase. This slow increase in population of the insect pests can be attributed to the frequent spraying of biopesticides in the crop in which biopesticides are not only known to be effective against insect pest but remain safer to natural enemies (Patel et al., 2003). Likewise, Culliney and Pimentel (1986) concluded that organic farming methods promote crop-plant resistance to pest attack thus, reducing insect damage.

On the other hand, whiteflies (*Bemisia tabaci* G.), green leaf hopper (*Nephotettix virescens* D.), aphids (*Aphis gossypi* G.) thrips (*Thrips tabaci* L.) and eggplant fruit borer (*Leucinodes orbonalis* G.) were the five insect pests of eggplant observed during the conduct of the study. Whiteflies and green leaf hopper were observed from 28 to 82 DAT, aphids from 28 to 54 DAT, thrips from 54 to 82 DAT and fruit borer at 45 DAT and throughout the crops growth period. Among the five insect pests of eggplant observed, aphids were the most prevalent from 28 to 54 DAT with approximately 100aphids/10 plants. Regardless of treatment, the population declined for almost 60 percent at 35 DAT (Figure 9). Increase in population was monitored in succeeding observations at 42 and 49 DAT but not caused economic damage to the crop.

#### Disease Incidence (%) in the Experimental Field Under Conversion to Organic

Leaf blight (*Rhizoctonia solani* Kuhn) was the only disease observed in pechay at 14 DAE up to 28 DAE with percentage incidence ranging from 18.77 to 25.14 percent. Application of OF + FE once a week showed the lowest incidence of leaf blight and the highest incidence was observed in OF alone followed by OF + FE twice a week and OF + FE every two weeks. The use 20 t/ha of OF and weekly application of FE can regulate fungal disease such as *Rhizoctonia solani* since in the study of Abbasi et al., 2004 found out that fish emulsion as a pre-planting amendment to potting substrates and organic soil has shown effectiveness for controlling damping-off (*Rhizoctonia* and *Pythium* spp.) in cucumber and radish.

On the other hand, no disease was monitored in all the treatments of eggplant evaluated in the entire duration of the

study. This could be attributed to the application of fish emulsion that controls the occurrence of disease in which amendment of soil with fish emulsion at rates of 0.5% and 1% (m/m) protected eggplant from verticillium wilt (Abassi et al., 2006).

### Conclusion

Farmers who choose to convert their conventional farm to organic farm will not suffer abrupt or tremendous yield loss of crops due to shifting from inorganic fertilizer to OF, if the application of 20 t/ha OF with frequent supplementation of FE will be adopted by them. Likewise, continued application of organic fertilizer improved all the soil properties after each cropping resulting to better yield. Labor cost in land preparation and weeding were also reduced in different treatments with 20 t/ha + FE frequency. FE supplementation to organic solid fertilizer relatively reduced insect pest population and incidence of diseases.

Since majority of farmers are hesitant to adopt organic farming because of low yield when using organic fertilizer alone, results of the supplementation of FE to 20 t/ha OF will give new hope to them. The presence and abundance of microbial species in an organic farm should be also monitored.

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