EVALUATION OF ORGANIC FERTILIZERS ON SELECTED HIGHLAND VEGETABLES

Divina C. Jose

ABSTRACT

The project was conducted in BPI-Buguias Seedfarm and BPI-Baguio experimental farm from December 2013 to March 2016 to evaluate the effects of organic fertilizers and mulching materials on selected highland vegetables; identify the best or appropriate organic fertilizer and mulching material; determine their effects on the soil; and compare the profitability of using organic fertilizers and mulching materials for selected highland vegetables.

On organic fertilizers, chicken manure (4, 5 and 6 tons/ha), mushroom compost (6, 8 and 10 tons/ha), horse manure (6, 8 and 10 tons/ha) and vermicompost (8, 10 and 12 tons/ha) were applied on lettuce, broccoli and carrot, respectively, one week before transplanting/sowing. The application of chicken manure on the test crops enhanced the production of heaviest lettuce heads, broccoli curds and taproots of carrot, respectively, resulting in highest marketable yield. Its application also enhanced earliest harvest at 52 days and widest leaves on lettuce leading to widest plant canopy. This was followed by the application of mushroom compost. Control plants were latest to mature or harvest on lettuce; produced the lowest weight of lettuce heads, broccoli curds and taproots resulting in lowest marketable yield of the test crops. Meanwhile, all treatment plots decreased in pH in Baguio as well as phosphorus in both locations. Moreover, most plots planted to broccoli and carrot decreased in potassium but increased in plots planted to lettuce.

The application of chicken manure on lettuce, broccoli and carrot noted the highest return on investment of 152.19, 179.42 and 148.92 %, respectively followed by the application of mushroom compost on lettuce and broccoli, and application of horse manure on carrot.

RATIONALE

High value vegetables are considered one of the important products which heighten the economy of the Cordillera region. ATI-CAR (2011) mentioned that semi-temperate vegetable contributes 30-35% of the region's Gross Value Addition in agriculture, and vegetable gardening is the main source of livelihood of about 97,350 farmers mostly in Benguet province. Also, contributes about 80 to 85% of the vegetables in Metro Manila markets (Aquino, 2012).

High value vegetables such as lettuce, broccoli and carrots are good sources of vitamins and minerals and contain antioxidants which are important for wellness. In 2010 lettuce had a total production volume of 2,313.13 MT, broccoli with 1,928.33 MT and carrots with 56,011.25 MT from effective production areas of 229.38, 145.75 and 3,255.95 ha, respectively (BAS, 2011).

However, until now vegetable farmers strive to increase their production per area for higher income. This lead them grow vegetables through inorganic farming. Therefore, the use of synthetic pesticides, fertilizers and other chemicals flourished in the commercial vegetable growing areas. Though improved production, the environment and the populace are threatened compromising contamination, food safety and wellness. In the Cordillera, farmers usually apply chicken manure with combination of inorganic fertilizers at rates more than the recommended dosages that may contaminate the environment. According to Batt et. al (2008) there is a considerable potential to maintain or increase quality yields through improved cultural farm practices. Production of vegetables through the use of organic fertilizers is a cultural practice that could improve quality of produce at the same time maintaining healthy environment for future generations.

Application of organic fertilizers stimulates the natural cycles that ameliorate and enrich the soil, and nutrients are released over the years for crop growth and development (Snyder, 2009). Likewise, organic fertilizer increase water holding capacity, improve aeration and water infiltration (Davis and Wilson, 2012). Further, Balfour (2000) stated that organic farming preserves and enhances fertility of the soil because it encourages the activity of beneficial insects and microorganisms and minimizes flow of toxic pesticides into waterways. Besides, the soil and ecosystem is maintained healthy while producing safe vegetables for the communities. According to Stephens and Kostewicz (2009) building up or nourishing the soil with the use of organic materials is the major concept of organic gardening which is very sustainable.

REVIEW OF LITERATURE

Several authors stated that soil amendments are any material added and mixed to the soil in order to improve the physical properties and add nutrients into the soil for the benefit of the plants. They mentioned further that the common organic soil amendments are weed composts, animal manure composts, worm castings, rice hulls, wood shavings, green manures, blood meal, fish meal, feather meal and the like.

According to Davis and Wilson (2012) soil amendments are any materials which are mixed well to the soil and upon decomposition act as organic fertilizers. Soil with 3% organic matter needs 3 cubic yards (2.7 m^3) amendment per 1,000 square foot (295 sq.m). Generally, the application of 5 to 10 tons/ha is used for decades in the country boosting the yield of vegetable crops (DA, 2009). Moreover, DA (2013) stated that all types of lettuce grow best in cool areas but the optimum temperature ranges from 15 to 18 ^{o}C; head types require cooler temperatures ranging from 10 °C to 18 °C, and heading and seeding are prevented at 21 ^{o}C and above.

Turner (2012) also mentioned that adding organic material as a soil amendment can change soil pH levels and water retention ability, however, it is very important to know the soil type first before applying any amendment to ensure nourishment of the soil and not making it worse. He explained further that organic compost releases its nutrients slowly over a period of time providing nutrition for plants far into the future. Likewise, Snyder (2009) mentioned that organic soil amendment stimulates the natural cycles that enrich the soil. Earthworms and soil microorganisms break down organic matter and nutrients are slowly released over months or years for plants.

Stephens and Kostewicz (2009) stressed that composting is the microbial decomposition of organic wastes under controlled condition and the end product is artificial manure used as a soil amendment and a source of nutrient. Also, Abadilla (1982) described composting as an ancient technology of piling, mixing and decaying of natural wastes in a heap or pit to obtain a compost rich in humus. Moreover, he cited some literatures which stated that the efficacy of animal manures lasts from one to 5 years. Others defined it as the process by which humus is manufactured by deliberately speeding up the normal rate of cellulose decomposition.

Gurel and Miller (2010) stressed that in order that animal manure can be used for organic production, it must be fully composted, or incorporated into the soil 120 days prior to the harvest of organic lettuce. Moreover, approved amendments such as blood meal, fish meal and feather meal can also increase the marketable yield and quality of lettuce. In 2006, Hammermeister, et. al applied different organic amendments at the rate of 200, 400 and 800 kg total nitrogen per hectare in unvegetated soil planted with lettuce and orchardgrass, and available nitrogen was measured after six months. They found that vermicastings with available N at 10% is safe for lettuce while high rates of poultry manure and feather meal with available N of 50 to 70% are toxic, but produced good orchardgrass.

Okur et. al (2007) stated that the application of farmyard manure and tobacco waste compost at 50 tons/ha as organic amendment increased lettuce yield, and may as well increase crop yield in dryland especially in Mediterranean soil with low organic matter content. Further, 25% farmyard manure +75% tobacco waste compost and 100% tobacco waste compost increased soil biological properties such as soil organic C, total N, soil respiration and certain kinds of enzyme activity. However, MSU (2010) mentioned that if soil N supply is greater than crop demand, excessive nitrate (NO_3) may enter the ground or surface water. Moreover, Nitrogen in the vegetation of field crops is approximately 2-3% of dry matter weight and organic matter is approximately 5%N, so total nitrogen in the topsoil ranges from 227.27 to 909 kg/0.4 ha. Further, the optimum nutrients in soils are 50-150 ppm NO_3, 10-20 ppm P and 120-200 ppm K for crops.

Mc Gitten (2010) stated that when he applied organic amendments in desert soil low with organic carbon and planted with legumes and lettuce, he found that yields in the first year were low compared to that plots with inorganic fertilizer but were equal during the second year. Also, soil respiration is related to the amount of organic carbon added as either cover crop or compost, indicating that microbes were degrading and using the organic residues as an energy source thus, scarce organic carbon in desert soils.

The addition of organic matter can aid in reducing diseases caused by soilborne pathogens; the incidence of lettuce drop and survival rate of *Sclerotinia sclerotiorum* can be reduced by adding stable manure (mixture of straw, horse dung and urine), fowl manure (mixture of chicken droppings and wood shavings) and Lucerne hay in the field (Gurel and Miller, 2010). Earlier, Okpala (2008) tested several organic soil amendments against damping off of lettuce seedlings and noted that grass meal amendment was effective as thiram seed treatment in protecting lettuce seedlings against *Corticium praticola* as well as effective in reducing the survival of the fungus in the soil.

The application of soil amendments rich in potassium like wood ashes contain soluble potassium which boost the plant quickly and promotes strong storage root development, promoting solid and sweet carrots. Moreover, white mold on carrots caused by *Sclerotinia sclerotiorum* was prevalent on stalks and roots harvested from plots applied with chemical fertilizer but absent in roots from plots applied with raw lobster waste (Agriculture and Agri-Food and PEI Department of Agriculture, Fisheries and Aquaculture Canada, 2004). They added that on potato tuber yield from plots applied with raw lobster waste was found similar to the yield from plots applied with chemical fertilizer, and the severity of black scurf caused by *Rhizoctonia solani* has been lower on tubers from plots receiving lobster waste

BAS (2005) as cited by Centrosaka.org (2012) stressed that the country's top highland vegetable producing areas were Benguet and Mt. Province, Ilocos Sur, Bukidnon and North Cotabato. In 2005, the country had a production volume of 16,800 MT (11.50 tons/ha) for carrot, 1,400 MT (10.6 tons/ha) for broccoli and 1,600 MT (7.2 tons/ha) for lettuce with Benguet and Mt. Province, Bukidnon and Cotabato are the major producers. Later, the same author (2011) noted that the production volume of same crops are 1,233.18 MT, 1,863.96 MT and 58,766.14 MT from production areas of 159 ha, 163 ha and 3,359 ha, respectively.

OBJECTIVES

1. To evaluate the effects of organic fertilizers on the performance of selected highland vegetables;

2. To identify the best organic fertilizer for the selected highland vegetables;

3. To determine the effects of organic fertilizers on the properties of the soil; and

4. To compare the profitability of the different organic fertilizers for selected highland vegetables.

METHODOLOGY

Lettuce (Rommaine type, var. Xanadu), broccoli (var. Legacy) and carrots (var. New Kuroda) were planted in BPI Buguias Seedfarm and BPI-Baguio from December 2013 to April 2014 and December 2014 to March 2015, respectively (Table 1). Lettuce and broccoli were sown under greenhouse and transplanted in the field when three to four leaves developed while carrots was direct seeded in plots in the field.

An area of 400 square meters was cleared and thoroughly prepared for planting. Plots measured 1 X 6 meters for the three crops. Lettuce was spaced 20 X 30 cm between hills and rows and broccoli at 30 X 40 cm, following the double row planting while carrots was spaced 15 X 10 cm consisting five rows in a plot (Table 1). Randomized complete block design was used for the study. There were five treatments (Table 2) for each crop which were replicated three times.

Table 1. The different test crops and plant spacing used in the trials

Test crop	Planting Distance (cm)
Lettuce	20 X 30
Broccoli	30 X 40
Carrots	15 X 10

Table 2. The different treatments and decomposed organic fertilizers and their rates of application

Treatment	Lettuce (t/ha)	Broccoli (t/ha)	Carrots (t/ha)
T_0-Control (no organic fertilizer)	0	0	0
T_1-Chicken manure	4	5	6
T_2-Mushroom compost	6	8	10
T_3-Horse manure	6	8	10
T4-Vermicompost	8	10	12

The different fully decomposed organic fertilizers were applied basally one week before transplanting/sowing. Chicken manure was bought from farm suppliers in the locality and the sources are poultries from Batangas, Tarlac and Laguna. Horse manure is taken from Lualhati barangay, Baguio with some farmers practicing organic farming. Mushroom compost is obtained from mushroom farmers in Baguio, and vermicompost is bought from farm suppliers where some sources are from the lowlands. Chicken manure, mushroom compost and vermicompost are very much available.

Other cultural management practices such as weeding, watering and hilling up were done as needed for the growth and development of the crops.

The data gathered were the following:

1. Initial and final chemical analysis of the soil. Before land preparation and after harvest, soil samples were collected and submitted to the Bureau of Soils for initial and final pH, OM (%), P (ppm) and K (ppm) analysis.

2. Chemical analysis of the different decomposed organic fertilizer. Samples were submitted to the Bureau of Soils for analysis.

3. Lettuce

Ten (10) sample plants selected at random were used in gathering leaf length, leaf width, plant canopy diameter, number of leaves and weight per plant one day before harvest.

a. Days to harvesting. Days were counted after transplanting to harvesting.
b. Leaf length (cm). Longest leaves were measured from sample plants.
c. Leaf width (cm). Leaf samples were measured at the widest part.
d. Plant canopy diameter (cm). Plant canopy was measured at the widest part of sample plants.
e. Number of leaves. Loose leaves were counted excluding the inner capped portion.
f. Weight per plant (g). Ten (10) randomly selected sample plants were harvested and weighed individually.
g. Marketable yield (kg/plot). Sound plants were harvested and weighed in kg/plot and computed in tons per hectare.
h. Non-marketable yield (kg/plot). Diseased plants and hollow heads were harvested and weighed in kg/ plot and computed in tons per hectare.
i. Incidence of insect pests and diseases. Occurrence of insect pests and diseases were assessed during the crop growth duration.

4. Broccoli

Ten (10) samples selected at random were used in gathering height, curd diameter, and weight per curd.

a. Height (cm). Ten randomly selected sample plants were measured from the base to the tip of the developing curd (1 peso curd size).
b. Curd diameter (cm). Ten insect pest damage and disease-free curds ready for harvesting were measured at the widest part.
c. Weight per curd (g). Ten marketable curds were harvested with three leaves and weighed individually.
d. Marketable yield (kg/plot). Curds which are free from insect pest damage and diseases were harvested mushroom cut with three leaves, weighed and computed in tons per hectare.
e. Non-marketable yield (kg/plot). Very small uneven curds were harvested, weighed and computed in tons per hectare.
f. Incidence of insect pests and diseases. Occurrence of insect pests and diseases were assessed during the cropping period.

5. Carrot

Ten (10) taproot samples selected at random were used in gathering taproot length, taproot diameter, core diameter and weight per taproot.

a. Taproot length (cm). Length of taproots was measured after harvest.
b. Shoulder diameter (cm). The shoulder part of the taproots was measured with the use of a Vernier caliper.
c. Core diameter (cm). Taproots were cut at the shoulder then core diameter was measured.
d. Weight per taproot (g). Taproots were weighed individually.
e. Marketable yield (kg/plot). Disease-free taproots were weighed in kg/ha and further computed into tons per hectare.
f. Non-marketable yield (kg/plot). These are diseased, very small, cracked, spindled and forked taproots which were weighed in kg/ha and further computed in tons per hectare.
g. Incidence of insect pests and diseases. Occurrence of insect pests and diseases were monitored and assessed during the cropping period.

5. Statistical Analysis

Data were analysed through analysis of variance and further analysis was done through Duncans Multiple Range Test for mean separation.

RESULTS AND DISCUSSIONS

Description of the site

The first trial site was a transition for organic farm in Buguias Seedfarm. The area was slightly sloping with silty loam soil which is friable, previously planted with cabbage, experienced low temperature for as low as 5^0C for the months of December 2013 to January 2014, and no problem on water runoff from other farms. The second trial area in Baguio on December 2014 to March 2015 was previously planted with squash then fallowed for two years. The area was surrounded by a concrete irrigation canal and no water flow problem coming from other paddies. Further, the area has a clay loam soil, and the surrounding areas were planted with indigenous vegetables and legumes practicing organic and inorganic farming, respectively.

Lettuce

Days to harvesting

Among the treatments, plants applied with chicken manure significantly were earliest to mature and harvested at 52 days (Table 3). This could be due to the higher absorption of organic matter by plants and higher potassium content in the soil after harvest (Table 6) that was used in translocation of food leading to faster growth and maturity. Control plants were the latest to mature and harvested at 70 days. Plants applied with mushroom compost, horse manure and vermicompost had matured and harvested at 66 days after transplanting. Late maturity was observed in Buguias than in Baguio may be due to very cold weather sometimes to as low as 5 ^{o}C. The maturity period by the treatment plants conform with many literatures that the commercial maturity of Rommaine lettuce is 55-70 days.

Leaf length and width

There were no significant differences on the length of leaves as affected by the different organic fertilizers ranging from 17.99 to 20.57 cm.

Plants applied with chicken manure significantly had the widest leaves with mean of 12.32 cm. Other organic fertilizers applied plants together with the control had leaf widths ranging from 9.26 to 10.20 cm. Wider leaves could be due to higher absorption of organic matter and higher potassium content in the soil (Table 6) that was may be used by plants in translocation of food to the different plant parts.

Table 3. Days to harvest, leaf length and width of lettuce as affected by organic fertilizers

Treatment	Days to harvest		Mean	Leaf length (cm)		Mean	Leaf width (cm)		Mean
	Buguias 2014	Baguio 2015		Buguias 2014	Baguio 2015		Buguias 2014	Baguio 2015	
Control	80[a]	60[a]	**70[a]**	15.58[a]	20.40[a]	**17.99[a]**	8.83[b]	11.40[b]	**10.11[b]**
Chicken manure	55[c]	49[c]	**52[c]**	17.00[a]	20.60[a]	**18.80[a]**	12.13[a]	12.52[a]	**12.32[a]**
Mushroom compost	76[b]	55[b]	**66[b]**	17.73[a]	20.60[a]	**19.16[a]**	9.30[b]	11.11[b]	**10.20[b]**
Horse manure	76[b]	55[b]	**66[b]**	18.33[a]	21.17[a]	**19.75[a]**	9.23[b]	10.26[b]	**9.74[b]**
Vermicompost	76[b]	55[b]	**66[b]**	18.15[a]	23.00[a]	**20.57[a]**	8.20[b]	10.32[b]	**9.26[b]**
Significance	**	**	**	ns	ns	ns	**	**	**
CV (%)	1.60	1.59	1.55	8.02	7.93	7.99	7.06	10.54	9.02

Means with the same letter in a column are not significantly different at 5% level by DMRT.

Plant canopy diameter

Table 4 shows that chicken manure applied plants significantly registered the widest plant canopy with mean of 24.07 cm may be because of having the widest leaves while control and other organic fertilizers applied plants had narrower plant canopy ranging from 19.41 to 20.85 cm (Table 4).

Number of leaves

There were no significant differences on the number of leaves as affected by organic fertilizers with mean ranging from 21 to 22.

Table 4. Plant canopy and number of leaves of lettuce as affected by organic fertilizers

Treatment	Plt canopy dia(cm) Buguias 2014	Plt canopy dia(cm) Baguio 2015	Mean	No. of leaves Buguias 2014	No. of leaves Baguio 2015	Mean
Control	17.03[b]	21.80[b]	**19.41[b]**	17[a]	25[a]	**21[a]**
Chicken manure	25.06[a]	23.09[a]	**24.07[a]**	16[a]	27[a]	**21[a]**
Mushroom compost	17.70[b]	23.16[a]	**20.43[b]**	18[a]	26[a]	**22[a]**
Horse manure	18.23[b]	21.00[b]	**19.61[b]**	18[a]	26[a]	**22[a]**
Vermicompost	17.33[b]	24.38[a]	**20.85[b]**	18[a]	26[a]	**22[a]**
Significance	**	**	**	ns	ns	ns
CV (%)	5.42	6.50	6.25	4.51	2.94	3.90

Means with the same letter in a column are not significantly different at 5% level by DMRT.

Weight per head

Plants applied with chicken manure were significantly the heaviest with mean of 351 grams/head followed by mushroom compost with 273.65 grams while the lowest weight was obtained from the control plants with 216.41 grams/head (Table 5). Horse manure and vermicompost applied plants had weights of 256.75 and 253.38 grams/head, respectively. Heavy heads could be due to wider leaves and wider plant canopy.

Marketable yield

The highest marketable weight was taken from plants applied with chicken manure with mean of 27.72 tons/ha followed by plants applied with mushroom compost with 20.75 tons/ha while the lowest was from the control with 15.04 tons/ha (Table 5 and Fig.1 and Fig. 1a). Horse manure and vermicompost applied plants had mean marketable yields of 18.67 and 18.40 tons/ha, respectively. The highest marketable yield was attributed to heavier weights of heads.

Non-marketable yield

Lettuce plants applied with different organic fertilizers and the control plants had comparable non-marketable weights ranging from 0.78 to 1 ton/ha.

Incidence of Insect pests and diseases

There were no insects observed during the cropping period but rotting was noted insignificantly at harvesting stage.

Table 5. Weight per head, marketable and nonmarketable yield of lettuce as affected by organic fertilizers

Treatment	Weight per head Buguias 2014	Weight per head Baguio 2015	Mean	Marketable Yield (t/ha) Buguias 2014	Marketable Yield (t/ha) Baguio 2015	Mean	Nonmarketable Yield (t/ha) Buguias 2014	Nonmarketable Yield (t/ha) Baguio 2015	Mean
Control	152.83^{d}	280^{c}	**216.41 ^{d}**	12.67^{c}	17.41^{c}	**15.04^{c}**	0.76^{a}	0.81^{ab}	**0.78^{a}**
Chicken manure	302.00^{a}	400^{a}	**351.00 ^{a}**	28.99^{a}	26.45^{a}	**27.72^{a}**	0.78^{a}	1.15^{a}	**0.96^{a}**
Mushroom compost	192.30^{b}	355^{b}	**273.65 ^{b}**	18.46^{b}	23.04^{ab}	**20.75^{b}**	0.96^{a}	1.04^{a}	**1.00^{a}**
Horse manure	173.50^{c}	340^{b}	**256.75 ^{c}**	16.65^{b}	20.69^{b}	**18.67^{b}**	0.86^{a}	0.89^{ab}	**0.87^{a}**
Vermicompost	156.76^{d}	350^{b}	**253.38 ^{c}**	15.04^{bc}	21.76^{b}	**18.40^{b}**	0.78^{a}	0.96^{ab}	**0.87^{a}**
Significance	**	**	**	**	**	**	ns	ns	ns
CV (%)	1.27	3.83	2.75	1.05	4.96	3.00	4.51	5.68	5.00

Means with the same letter in a column are not significantly different at 5% level by DMRT.

Fig.1. Marketable heads at harvesting

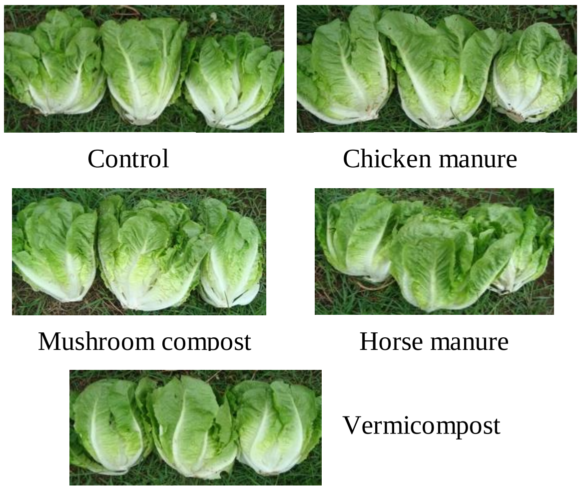


Fig.1a. Harvested lettuce applied with organic fertilizers

Initial and final analysis of the soil planted to lettuce

The initial pH of the soil was 6.50 and 6.13 in Buguias and Baguio, respectively, which are within the pH requirement of lettuce. Organic matter was high in Buguias with 15% but low in Baguio with 2%; both locations were high in phosphorus with 270 and 100 ppm; and high potassium with 278 and 430 ppm, respectively.

After harvest, plots applied with different organic fertilizers including the control had decreased in pH from 6.13 to a range of 5.4 to 5.8 (Table 6). The organic matter contents of all treatment plots had decreased in Buguias from 15 % to as low as 10 % which may be due to plants absorption or leaching because the area has a silty loam soil but remained in Baguio at 2 % having a clay loam soil. Likewise, phosphorus contents decreased from an initial of 270 to a range of 84 to 235 ppm in Buguias and from 100 ppm to a range of 6 to 9 ppm in Baguio. Meanwhile, most of the treatments increased in potassium contents both in Buguias and Baguio from 278 and 430 ppm to a range of 128 to 574 ppm may be because of the nutrient supplied by the organic fertilizers and lettuce has a short growth duration that is harvested in its vegetative stage thereby potassium contents were not depleted.

Table 6. The pH, organic matter, phosphorus and potassium content of the soil planted to lettuce as affected by organic fertilizers

Treatment	pH		OM (%)		P (ppm)		K (ppm)	
	Buguias 2014	Baguio 2015	Buguias 2014	Baguio 2015	Buguias 2014	Baguio 2015	Buguias 2014	Baguio 2015
Control	6.3	5.5	12.50	2	100	9	128	218
Chicken manure	6.2	5.8	10.00	2	84	6	374	574
Mushroom compost	6.5	5.4	12.50	2	175	6	334	434
Horse manure	6.6	5.6	12.50	2	235	8	340	440
Vermicompost	6.5	5.6	12.50	2	114	8	320	380
Initial analysis	6.50	6.13	15.0	2	270	100	278	430

Return on Investment of lettuce

Lettuce applied with chicken manure registered the highest return on investment of 152.19 % followed by lettuce applied with mushroom compost with 91.92 % (Table 7 and Appendix Table 1) because of high yield. Lowest ROI was taken from lettuce applied with vermicompost with 42.76 % because of higher production cost.

Table 7. Return on investment of lettuce

Treatments	Production Cost	Yield (kg/ha) Less 10% spoilage & price fluctuation (Php15/kg)	Gross Income (Php)	Net Income (Php)	ROI (%)
No fertilizer	134,000	13,536	203,040	69,040	51.52
Chicken manure	148,400	24,950	374,250	225,850	152.19
Mushroom compost	146,000	18,680	280,200	134,200	91.92
Horse manure	148,400	16,800	252,000	103,600	69.81
Vermicompost	174,000	16,560	248,400	74,400	42.76

Broccoli

Plant height

Plants applied with the different organic fertilizers were comparable and taller with mean heights ranging from 22.30 to 23.53 cm than control plants with 20.06 cm (Table 8). Taller plants could be attributed to the nutrients supplied by the organic fertilizers in the soil enhancing growth of plants.

Curd diameter

It was observed that plants applied with the different organic fertilizers produced wider curds which range from 9.06 to 10.97 cm compared to the control plants with 8.13 cm. Wider curd was may be because of nutrients supplied by the organic fertilizers which promoted the growth of curds.

Weight per curd

Chicken manure applied plants significantly produced the heaviest curd with 306.42 grams followed by plants applied with mushroom compost with 212.61 grams which could be brought by wider curd diameter. The lowest weight was produced by control plants with 164.58 grams. Plants applied with horse manure and vermicompost had weights of 194.68 and 185.45 grams, respectively.

Table 8. Height, curd diameter and weight per curd of broccoli as affected by organic fertilizers

Treatment	Height (cm)		Mean	Curd dia. (cm)		Mean	Wt./ curd (g)		Mean
	Buguias 2014	Baguio 2015		Buguias 2014	Baguio 2015		Buguias 2014	Baguio 2015	
Control	15.45^{b}	24.97^{b}	**20.06^{b}**	6.29^{bc}	9.97^{b}	**8.13^{b}**	179.16^{d}	150^{c}	**164.58^{cd}**
Chicken manure	20.16^{a}	26.90^{a}	**23.53^{a}**	9.90^{a}	11.50^{a}	**10.97^{a}**	312.83^{a}	300^{a}	**306.42^{a}**
Mushroom compost	18.60^{a}	26.07^{a}	**22.34^{a}**	7.25^{b}	10.86^{a}	**9.06^{a}**	225.21^{b}	200^{b}	**212.61^{b}**
Horse manure	17.73^{a}	26.50^{a}	**22.30^{a}**	6.96^{b}	11.34^{a}	**10.65^{a}**	199.36^{c}	190^{b}	**194.68^{c}**
Vermicompost	18.36^{a}	27.23^{a}	**22.80^{a}**	7.05^{b}	11.27^{a}	**9.16^{a}**	190.90^{d}	180^{b}	**185.45^{c}**
Significance	**	**	**	**	**	**	**	**	**
CV (%)	13.64	19.67	17.65	3.53	5.75	5.25	2.91	14.14	4.26

Means with the same letter in a column are not significantly different at 5% level by DMRT.

Marketable yield

Among the treatments, plants applied with chicken manure produced the highest marketable weight of 18.11 tons/ha which could be due to wider curd diameter and heavy curds (Table 9 and Fig. 2 and 2a). This was followed by plants applied with mushroom compost with 12.42 tons/ha, horse manure applied plants with 11.48 tons/ha and vermicompost applied plants with 11.17 tons/ha. Control plants produced the lowest marketable yield of 9.64 tons/ha.

Nonmarketable yield

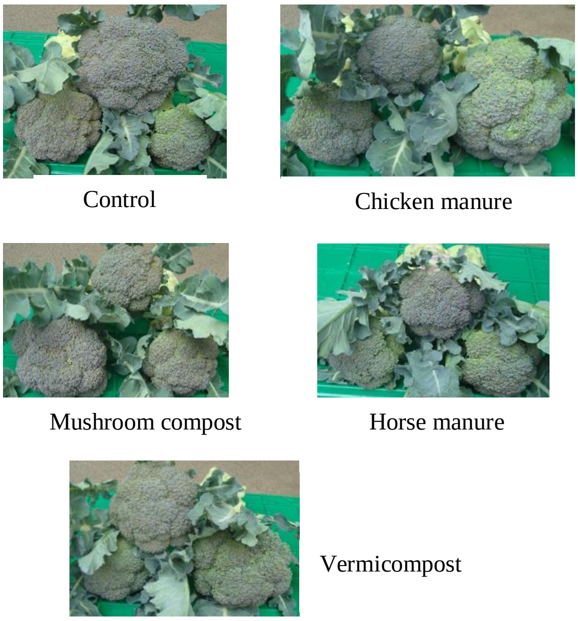
There were no significant differences on the nonmarketable yield ranging from 0.68 to 1.14 tons/ha.

Table 9. Marketable and nonmarketable yield of broccoli as affected by organic fertilizers

Treatment	Marketable yield (t/ha)		Mean	Nonmarketable yield (t/ha)		Mean
	Buguias 2014	Baguio 2015		Buguias 2014	Baguio 2015	
Control	10.75[d]	8.52[c]	**9.64[c]**	1.05[c]	0.30[a]	**0.68[ab]**
Chicken manure	18.77[a]	17.45[a]	**18.11[a]**	1.86[a]	0.42[a]	**1.14[a]**
Mushroom compost	13.51[b]	11.33[b]	**12.42[b]**	1.40[b]	0.40[a]	**0.90[a]**
Horse manure	11.96[c]	10.99[bc]	**11.48[b]**	1.66[b]	0.48[a]	**1.07[a]**
Vermicompost	11.45[c]	10.88[bc]	**11.17[b]**	1.48[b]	0.35[a]	**0.92[a]**
Significance	**	**	**	**	ns	ns
CV (%)	3.9	6.59	5.25	2.53	20.98	11.17

Means with the same letter in a column are not significantly different at 5% level by DMRT.

Fig.2. Harvesting of marketable broccoli curd



Control Chicken manure

Mushroom compost Horse manure

Vermicompost

Fig.2a. Harvested broccoli applied with organic

Incidence of insect pests and diseases

Larvae of Lepidopterous insect were observed insignificantly on the leaves but do not have bearing on the produce because the occurrence was near harvesting stage. There were no diseases observed during the crop growth duration.

Initial and final chemical analysis of the soil planted to broccoli

The initial pH of 6.50 and 6.13 in Buguias and Baguio, respectively, are within the pH requirement of broccoli. Organic matter was high at 15% in Buguias but low in Baguio with 2%; both locations were high in phosphorus with 270 and 100 ppm; and high potassium at 278 and 430 ppm, respectively.

After harvest, control and chicken manure applied plots in Buguias and all treatment plots in Baguio had little decreases in pH from 6.50 to 6.2 (Buguias) and from 6.13 to as low as 5.4 (Baguio) may be due to leaching of nutrients (Table 10). On organic matter, all treatment plots in Buguias decreased from 15 % to 12.50 % except chicken manure applied plots and all treatment plots in Baguio that remained the same at 15 % and 2 %, respectively.

Phosphorus contents tremendously decreased in all treatment plots from 270 to as low as 100 ppm in Buguias and from 100 to 3 ppm in Baguio, may be because plants have absorbed much for root development. It was also observed that most treatment plots decreased in potassium except chicken manure and vermicompost applied plots in Buguias with 316 and 320ppm from 278 ppm and chicken manure applied plots in Baguio that increased to 560 from 430 ppm. Meanwhile, plants may be had absorbed much of phosphorus and potassium for root and curd development, respectively, considering the potassium content of the organic fertilizers.

Table 10. The pH, organic matter, phosphorus and potassium content of the soil planted to broccoli as affected by organic fertilizers

Treatment	pH		OM (%)		P (ppm)		K (ppm)	
	Buguias 2014	Baguio 2015	Buguias 2014	Baguio 2015	Buguias 2014	Baguio 2015	Buguias 2014	Baguio 2015
Control	6.2	5.4	12.50	2	100	7	108	420
Chicken manure	6.2	5.7	15.00	2	128	5	316	560
Mushroom compost	6.6	5.7	12.50	2	200	3	270	408
Horse manure	6.5	5.7	12.50	2	245	6	320	420
Vermicompost	6.6	5.6	12.50	2	185	6	276	370
Initial analysis	6.50	6.13	15.0	2	270	100	278	430

Return on Investment of broccoli

Highest return on investment was obtained from broccoli applied with chicken manure at 179.42 % followed by broccoli applied with mushroom compost at 88.72 % (Table 11 and Appendix Table 2) because of high yield. Lowest ROI was taken from broccoli applied with vermicompost at 37.97 % because of higher cost of the compost. Broccoli applied with horse manure and the control plants had ROI of 70.69 and 64.27 %, respectively.

Table 11. Return on investment of broccoli

Treatments	Production Cost	Yield (kg/ha) Less 10% spoilage & price fluctuation (Php25/kg)	Gross Income (Php)	Net Income (Php)	ROI (%)
No fertilizer	132,100	8,680	217,000	84,900	64.27
Chicken manure	152,100	17,000	425,000	272,900	179.42
Mushroom compost	148,100	11,180	279,500	131,400	88.72
Horse manure	151,300	10,330	258,250	103,600	70.69
Vermicompost	182,100	10,050	251,250	69,150	37.97

Carrot

Taproot length, taproot diameter and core diameter had no significant differences among treatments as affected by different organic fertilizers with means ranging from 11.53 to 13.21 cm, 3.46 to 4.26 cm and 1.29 to 1.47 cm, respectively (Table 12).

Table 12. Taproot length, shoulder and core diameter of carrot as affected by organic fertilizers

Treatment	Root Length (cm) Buguias 2014	Root Length (cm) Baguio 2015	Mean	Shoulder dia. (cm) Buguias 2014	Shoulder dia. (cm) Baguio 2015	Mean	Core dia. (cm) Buguias 2014	Core dia. (cm) Baguio 2015	Mean
Control	10.32^{c}	12.73^{a}	**11.53^{a}**	3.61c	3.30^{a}	**3.46^{a}**	0.92^{a}	1.69^{a}	**1.31^{a}**
Chicken manure	12.00^{a}	13.30^{a}	**12.65^{a}**	4.77a	3.75^{a}	**4.26^{a}**	1.03^{a}	1.88^{a}	**1.46^{a}**
Mushroom compost	12.42^{a}	13.90^{a}	**13.21^{a}**	4.08b	3.37^{a}	**3.73^{a}**	1.03^{a}	1.55^{a}	**1.29^{a}**
Horse manure	11.43^{b}	14.03^{a}	**12.73^{a}**	4.70a	3.40^{a}	**4.05^{a}**	1.05^{a}	1.89^{a}	**1.47^{a}**
Vermicompost	11.78^{b}	14.33^{a}	**13.06^{a}**	4.13b	3.46^{a}	**3.80^{a}**	1.03^{a}	1.76^{a}	**1.40^{a}**
Significance	**	ns	ns	**	ns	ns	ns	ns	ns
CV (%)	4.81	4.62	4.00	2.72	10.16	8.34	3.01	8.71	6.72

Means with the same letter in a column are not significantly different at 5% level by DMRT.

Weight per taproot

Chicken manure applied plants remarkably produced the heaviest taproot with 87.78 grams while control plants had the lowest taproot weight of 62.78 grams (Table 13). Heavier taproot was may be because of higher potassium in the soil that enhanced the growth and development of the storage roots. Plants applied with other organic fertilizers had comparable taproot weights ranging from 70.74 to 75.50 grams.

Marketable yield

The highest marketable yield was taken from plants applied with chicken manure with 23.15 tons/ha while control plants had the lowest marketable yield of 13.87 tons/ha (Table 13 and Fig. 3). Marketable yields from plants applied with other organic fertilizers were comparable with a range of 19.11 to 20.67 tons/ha. The highest marketable yield was attributed to heavier taproots from plants applied with chicken manure.

Nonmarketable yield

Highest nonmarketable yield was produced from plants applied with chicken manure with 1.04 tons/ha may be due to higher weight of taproots while the lowest was obtained from the control plants with 0.55 tons/ha. These nonmarketable taproots were the cracked, spindled, forking and very small.

Table 13. Weight per taproot, marketable and nonmarketable yield of carrot as affected by organic fertilizers

Treatment	Weight per root Buguias 2014	Weight per root Baguio 2015	Mean	Marketable Yield (t/ha) Buguias 2014	Marketable Yield (t/ha) Baguio 2015	Mean	Nonmarketable Yield (t/ha) Buguias 2014	Nonmarketable Yield (t/ha) Baguio 2015	Mean
Control	48.29^{bc}	77.26^{c}	62.78^{c}	11.58^{c}	16.17^{b}	13.87^{c}	0.82^{d}	0.28^{b}	0.55^{b}
Chicken manure	77.90^{a}	97.66^{a}	87.78^{a}	18.69^{a}	27.60^{a}	23.15^{a}	1.56^{a}	0.52^{a}	1.04^{a}
Mushroom compost	61.48^{b}	80.00^{b}	70.74^{b}	14.75^{b}	23.47^{b}	19.11^{b}	1.02^{b}	0.28^{b}	0.65^{b}
Horse manure	54.22^{b}	95.88^{ab}	75.50^{b}	14.22^{b}	27.11^{a}	20.67^{b}	0.96^{c}	0.47^{a}	0.72^{b}
Vermicompost	55.79^{b}	94.66^{ab}	75.23^{b}	13.39^{b}	26.76^{a}	20.08^{b}	1.01^{b}	0.47^{a}	0.74^{b}
Significance	**	**	**	**	**	**	**	**	**
CV (%)	8.94	1.62	5.05	8.93	1.64	4.55	6.96	2.47	5.27

Means with the same letter in a column are not significantly different at 5% level by DMRT.

Fig. 3. Harvesting of carrots

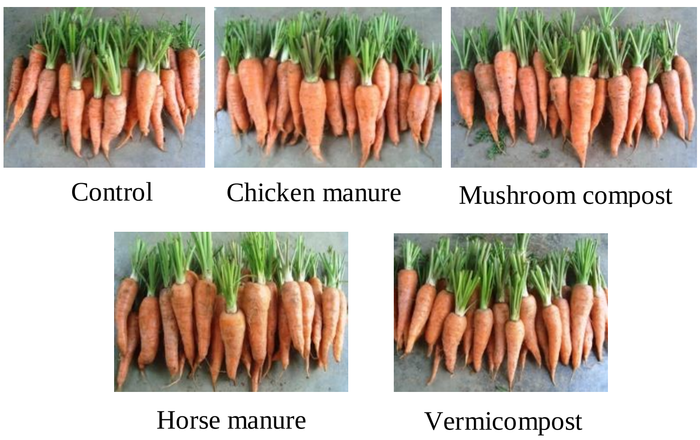


Fig. 3a. Harvested carrot applied with organic

Incidence of Insect pests

There were no insect pests and diseases observed during the cropping period.

Initial and final chemical analysis of the soil planted to carrots

Buguias and Baguio had initial pH of 6.20 and 6.13, respectively, which is good for carrots. Organic matter was high at 15% in Buguias but low in Baguio with 2%; both locations were high in phosphorus with 140 and 100 ppm; and high potassium content at 216 and 430 ppm, respectively.

All treatment plots in Buguias had increased in pH from 6.20 to as high as 6.98 may be because of the added organic fertilizers and watering was not frequent as in Baguio with decreased in pH from 6.13 to as low as 5.50 may be due to leaching enhanced by water percolation during irrigation (Table 14).

Organic matter content of plots applied with organic fertilizers remained at 15 % in Buguias except control plots which decreased to 13.5 % may be due to nutrient absorption and no addition of nutrients, and in Baguio remained at 2 %. Considering the nutrients present in the organic fertilizers, plants could have absorbed much nutrients for their growth and development.

Table 14. The pH, organic matter, phosphorus and potassium content of the soil planted to carrot as affected by organic fertilizers

Treatment	pH		OM (%)		P (ppm)		K (ppm)	
	Buguias 2014	Baguio 2015	Buguias 2014	Baguio 2015	Buguias 2014	Baguio 2015	Buguias 2014	Baguio 2015
Control	6.31	5.50	13.5	2	50	4	176	226
Chicken manure	6.36	5.82	15.0	2	120	4	282	492
Mushroom compost	6.98	5.69	15.0	2	94	4	154	330
Horse manure	6.91	5.86	15.0	2	70	6	140	292
Vermicompost	6.86	5.56	15.0	2	77	6	152	360
Initial analysis	6.20	6.13	15.0	2	140	100	216	430

In Buguias, phosphorus content in mushroom compost, horse manure and vermicompost applied plots were almost half of the initial which is 140 ppm ranging from 70 to 94 ppm except control with tremendous decrease to as low as 50 ppm and chicken manure applied plots with little decrease at 120 ppm (Table 14). In Baguio all treatment plots were depleted from 100 ppm to as low as 4 ppm which may mean that plants had absorbed much of the phosphorus for development of taproots considering the phosphorus supplied by the organic fertilizers.

For potassium, most treatment plots had decreased both in Buguias and Baguio from 216 and 430 ppm to as low as 140 and 226 ppm, respectively, which could be due to more absorption for development of storage root (Table 14). Plots applied with chicken manure increased to 282 and 492 ppm in Buguias and Baguio, which could be due to high potassium content of the manure supplied in the soil.

Return on Investment of carrots

Carrots applied with chicken manure gave the highest ROI of 148.92 % which is brought by high yield while control plants had the lowest with 69.45 % (Table 15 and Appendix Table 3) due to low yield. Other treatments had ROI ranging from 80.05 to 107.41 %.

Table 15. Cost and return of carrot

Treatments	Production Cost (Php)	Yield (kg/ha) Less 10% spoilage & price fluctuation (Php18/kg)	Gross Income (Php)	Net Income (Php)	ROI (%)
No fertilizer	132,650	12,488	224,784	92,134	69.45
Chicken manure	156,650	20,840	375,120	218,470	148.92
Mushroom compost	152,650	17,200	309,600	156,950	102.82
Horse manure	156,650	18,050	324,900	168,250	107.41
Vermicompost	180,650	18,070	325,260	144,610	80.05

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

Lettuce

There were significant differences observed on days to harvest, leaf width, plant canopy, weight per head and marketable yield while insignificant differences were noted on leaf length, number of leaves and nonmarketable yield as affected by organic fertilizers.

Lettuce applied with chicken manure were earliest to harvest, produced widest leaves and plant canopy and produced heaviest weight per head leading to highest marketable yield. Lettuce applied with mushroom compost also produced wider leaves and plant canopy, produced heavier weight per head and higher marketable yield. Control plants were the latest to harvest, produced the lowest weight of heads and marketable yield. Plants applied with horse manure and vermicompost produced narrower leaves, narrower plant canopy, lower weight per head and lower marketable yield.

Broccoli

Significant differences were noted on plant height, curd diameter, weight per curd and marketable yield but no significant differences on nonmarketable yield as an effect of organic fertilizers.

Broccoli applied with chicken manure produced the heaviest curd leading to highest marketable yield followed by plants applied with mushroom compost. Control plants were the shortest, gave the narrowest curd diameter, lowest weight per curd and marketable yield. Other treatments applied with other organic fertilizers had produced lower weight of curds and marketable yield.

Carrot

There were significant differences on weight per taproot, marketable and nonmarketable yield but no significant differences on taproot length, shoulder and core diameter as affected by organic fertilizers.

Carrots applied with chicken manure produced the highest weight per taproot leading to the highest marketable and nonmarketable yield. Control plants had the lowest taproot weight, lowest marketable and nonmarketable yield. Other treatments had lower taproot weight leading to lower marketable and nonmarketable yield.

Chemical analysis of the soil

Most of the plots applied with organic fertilizers decreased in pH in both locations after harvest of the test crops. Also, most treatment plots decreased in organic matter in Buguias but remained same in Baguio. Further, all treatment plots decreased in phosphorus in both locations. Most treatment plots increased in potassium on soil planted to lettuce may be because of less nutrients absorbed brought by harvesting in vegetative stage but decreased on soil planted to broccoli and carrot in both locations may be due to more absorption by both crops for curd and storage root development.

Return on Investment

Return on investment was highest in the application of chicken manure on the test crops because of high marketable yield. This was followed by the application of mushroom compost on lettuce and broccoli but application of horse manure on carrot. The lowest ROI was taken from the application of vermicompost on lettuce and broccoli due to higher price of the organic fertilizer but on carrot was from the control due to low marketable yield.

Conclusions

Based on the results the following conclusions are drawn:

1. The application of organic fertilizers affected the growth and development of lettuce, broccoli and carrots in Buguias and Baguio.
2. The application of chicken manure enhanced the production of heaviest lettuce heads, broccoli curds and taproot of carrots resulting in highest marketable yields.
3. The application of mushroom compost also enhanced the production of heavier lettuce heads and broccoli curds, and application of horse manure on carrot enhanced heavier taproot, resulting in higher marketable yields.
4. The application of chicken manure is the most profitable for having the highest ROI on lettuce (152.19%), broccoli (179.42 %) and carrot (148.92 %) followed by the application of mushroom compost on lettuce and broccoli, and horse manure application on carrot.
5. Plots applied with organic fertilizers decreased in phosphorus content of the soil planted to the test crops in both locations; most plots applied with organic fertilizers had decreased in soil pH, decreased in potassium content of the soil planted to broccoli and carrot but increased in potassium content of the soil planted to lettuce.

Recommendations

The application of chicken manure is recommended for lettuce, broccoli and carrot for enhancing heaviest weight of produce resulting in highest yield and highest ROI. Mushroom compost can also be an alternate organic fertilizer for the three crops.

LITERATURE CITED

ABADILLA. D. 1982. Organic farming. AFA Publications, Inc. Quezon City, Philippines

AGRI BUSENESS WEEK. 2009. Farmers, growers, institutions unite to promote organic farming in Cordillera. Agri Business Week. www. agribusinessweek.com

AGRICULTURE AND AGRI-FOOD AND PEI DEPARTMENT OF AGRICULTURE, FISHERIS AND AQUACULTURE CANADA. 2004. Lobster processing waste for nutrition and disease control in potatoes and carrots. 2nd OACC Organic Research Workshop.

AQUINO, C. 2012. The Philippine vegetable industry almost comatose. www.focusonpoverty.org

ATI-CAR. 2011. The vegetable industry. Agricultural Training Institute. Benguet State University. La Trinidad, Benguet. Philippines. www.slideshare.net/aticar/vegetable-industry

BAS. 2005. Situationer on highland vegetables. Bureau of Agricultural Statistics-Crops Statistics Division. Quezon City. Philippines. Vol 2 http//bas.gov.ph

BAS. 2010. Regional crop statistics. Bureau of Agricultural Statistics. Baguio City. Philippines

BAS. 2011. Situationer on highland vegetables. Bureau of Agricultural Statistics. Baguio City. Philippines

BATT, P. J., S. CONCEPTION, K. DAGUPEN and R. M. PRIOR. The vegetable industry in the Philippines. The final report, ACIAR, Australia. http://www.aciar.gov.au/system/files/sites/aciar/files/node/4189/Final+report+ASEM-2005-062.pdf

centrosaka.org/publication. 2012. Situationer on highland vegetables

DAVIS, J.G. and C. R. WILSON. 2012. Choosing a soil amendment. Colorado State University Extension. www.ext.colostate.edu/Garden/07235.html

GUREL, F. B. and S. MILLER. 2010. Disease management in organic lettuce production in Organic Management. Ohio State University. http:/www.extension.org/pages/30849

HAMMERMEISTER, A.M., T. ASTATKIE, E.A. JELIAZKOVA, P.R. WARMAN and R.C. MARTIN. 2006. Nutrient supply from organic amendments applied to unvegetated soil, lettuce and orchardgrass. Canadian Journal of Soil Science. 86: 21-33

MCGITTEN, M. E., I. LEBRON, M. NGOUAJIO AND C. M. HUTCHINSON. 2010. Soil organic amendment change low organic matter agroecosystems. ISHS Acta Horticulture 638. XXVI International Horticulture Congress: Sustainability of Horticultureal Systems in the 21st Century

OKUR, N., H.H. KAYIKCIOLU, B. OKUR and S.DELBACAK. 2007. Organic amendment based on tobacco waste compost and farmyard manure: Influence on soil biological properties and butter-head lettuce. Ege University, Bornova, Turkey. http://journals.tubitak.gov.tr/agriculture/issues/tar-08-32-2/tar-32-2-2-0707-24.pdf

OKPALA, E. U. 2008. Effect of soil amendments on damping-off of lettuce caused by *Corticium praticola*. Annals of Applied Biology. Vol. 80 pp 155-162

STEPHENS, J.M. and S. R. KOSTEVICZ. 2009. Producing garden vegetables with organic soil amendments. Horticultural Sciences Department. Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, Gainsville FL 32611

SNYDER, M. 2009. Organic vegetable gardening blog-organic gardening tips and ideas.

TURNER, R. 2012. Soil amendments for organic vegetable gardens in Pacific Northwest. http://www.ehow.com/list7233091soil-vegetable-gardens-pacific-northwest.html#ixzz25fzBkPMi.

Appendix Table 1. Cost and Return of Lettuce applied with organic fertilizers*

I.Cost of Production		
A. Labor Cost Operation/Activity	Man Day (Php 300/day)	Value (Php)
1. Seedling tray preparation and care of seedlings	15	4,500
2. Plastic roofing installation for seedling protection	2	600
3. Land clearing	25	7,500
4. Plowing/plot preparation	30	9,000
5. Transplanting	30	9,000
6. Care and maintenance (weeding, fertilization, spraying & watering)	80	24,000
7. Harvesting	20	6,000
8. Sorting and packing	10	3,000
Sub-Total	**212**	**63,600**
B.Cost of Inputs, Supplies & Materials	Quantity	Value (Php)
1. Seeds	200g @1,500/50g	6,000
2. Biological pesticide	2li @ 500/li	1,000
3. Carton/plastic	1,500 @ 10/pc	15,000
4. Garden hose	10 rolls @ 1800/roll	18,000
5. Plastic twine	10 rolls @65/roll	650
6. Bamboo posts (for roof)	10 pcs @20/pc	200
7. Wire (for roof)	1kg @ 150/kg	150
8. Plastic sheet (roofing)	15 kg @ 200/kg	3,000
Sub-Total		**44,000**
C.Tools & Equipment		Depreciation Cost
1. Knapsack sprayer	2 units @ 2,500/unit	500
2. Rake	5 pcs @ 250/pc	125
3. Grab hoe	8 pcs @ 350/pc	280
4. Shovel	3 pcs @ 650/pc	190
5. Cythe	8 pcs @ 175/pc	140
6. Trowel	8 pcs @ 175/pc	140
7. Knife	5 pcs @ 50/pc	25
Sub-Total		**1,400**
D. Land rent, 10,000 sq.m. @ 25,000/3 mo.		**25,000**
Total Cost of Production		**134,000**

* Cost of labor, inputs and equipment were based on 2015 prices.

Treatments	Production Cost (Php)	Yield (t/ha)	Less 10% spoillage & price fluctuation (Php15/kg)	Gross Income (Php)	Net Income (Php)	ROI (%)
No fertilizer	134,000	15.04	13,536	203,040	69,040	51.52
Chicken manure	148,400	27.72	24,950	374,250	225,850	152.19
Mushroom compost	146,000	20.75	18,680	280,200	134,200	91.92
Horse manure	148,400	18.67	16,800	252,000	103,600	69.81
Vermicompost	174,000	18.40	16,560	248,400	74,400	42.76

Appendix Table 2. Cost and Return of Broccoli with application of organic fertilizers*

I.Cost of Production		
A. Labor Cost Operation/Activity	Man Day (Php 300/day)	Value (Php)
1. Seedling tray preparation and care of seedlings	10	3,000
2. Plastic roofing installation for seedling protection	2	600
3. Land clearing	25	7,500
4. Plowing/plot preparation	30	9,000
5. Transplanting	30	9,000
6. Care and maintenance (weeding, spraying, fertilization & watering)	80	24,000
7. Harvesting	20	6,000
8. Sorting and packing	10	3,000
Sub-Total	**207**	**62,100**
B.Cost of Inputs, Supplies & Materials	Quantity	Value (Php)
1. Seeds	350g @500/10g	17,500
2. Biological pesticide	2li @ 500/li	1,000
3. Basket	25 @ 150/pc	3,750
4. Garden hose	10 rolls @ 1800/roll	18,000
6. Bamboo posts (for roof)	10 pcs @20/pc	200
7. Wire (for roof)	1kg @ 150/kg	150
8.Plastic sheet (roofing)	15 kg @ 200/kg	3,000
Sub-Total		**43,600**
C.Tools & Equipment		Depreciation Cost
1. Knapsack sprayer	2 units @ 2,500/unit	500
2. Rake	5 pcs @ 250/pc	125
3. Grab hoe with handle	8 pcs @ 350/pc	280
4. Shovel	3 pcs @ 650/pc	190
5. Cythe	8 pcs @ 175/pc	140
6. Trowel	8 pcs @ 175/pc	140
7. Knife	5 pcs @ 50/pc	25
Sub-Total		**1,400**
D. Land rent, 10,000 sq.m. @ 25,000/3 mo.		**25,000**
Total Cost of Production		**132,100**

* Cost of labor, inputs and equipment were based on 2015 prices.

Treatments	Production Cost (Php)	Yield (t/ha)	Less 10% spoillage & price fluctuation (Php25/kg)	Gross Income (Php)	Net Income (Php)	ROI (%)
No fertilizer	132,100	9.64	8,680	217,000	84,900	64.27
Chicken manure	152,100	18.11	17,000	425,000	272,900	179.42
Mushroom compost	148,100	12.42	11,180	279,500	131,400	88.72
Horse manure	151,300	11.48	10,330	258,250	103,600	70.69
Vermicompost	182,100	11.17	10,050	251,250	69,150	37.97

Appendix Table 3. Cost and Return of Carrot applied with organic fertilizers*

I.Cost of Production		
A. Labor Cost Operation/Activity	Man Day (Php 300/day)	Value (Php)
1. Land clearing	25	7,500
2. Plowing/plot preparation	30	9,000
5. Sowing/planting (direct seeding)	30	9,000
6. Care and maintenance (weeding, thinning twice, spraying, fertilization & watering)	110	33,000
7. Harvesting	25	7,500
8. Sorting, packing & hauling	15	4,500
Sub-Total	**235**	**70,500**
B.Cost of Inputs, Supplies & Materials	Quantity	Value (Php)
1. Seeds	25 cans @450/300g	11,250
2. Biological pesticide	4 li @ 500/li	2,000
3. Sacks	450 pcs @ 10/pc	4,500
4. Garden hose	10 rolls @ 1800/roll	18,000
Sub-Total		**35,750**
C.Tools & Equipment		Depreciation Cost
1. Knapsack sprayer	2 units @ 2,500/unit	500
2. Rake	5 pcs @ 250/pc	125
3. Grab hoe with handle	8 pcs @ 350/pc	280
4. Shovel	3 pcs @ 650/pc	190
5. Cythe	8 pcs @ 175/pc	140
6. Trowel	8 pcs @ 175/pc	140
7. Knife	5 pcs @ 50/pc	25
Sub-Total		**1,400**
D. Land rent, 10,000 sq.m. @ 25,000/3 mo.		**25,000**
Total Cost of Production		**132,650**

* Cost of labor, inputs and equipment were based on 2015 prices.

Cost and Return of Carrot with application of organic fertilizers

Treatments	Production Cost (Php)	Yield (t/ha)	Less 10% spoilage & price fluctuation (Php18/kg)	Gross Income (Php)	Net Income (Php)	ROI (%)
No fertilizer	132,650	13.87	12,488	224,784	92,134	69.45
Chicken manure	156,650	23.15	20,840	375,120	218,470	148.92
Mushroom compost	152,650	19.11	17,200	309,600	156,950	102.82
Horse manure	156,650	20.06	18,050	324,900	168,250	107.41
Vermicompost	180,650	20.08	18,070	325,260	144,610	80.05