BIBLIOGRAPHY

MARCELO, PRECIL D. APRIL 2012. Effects of the Different Application Rates of Vermicompost on the Performance of Watercress ((*Nasturtium officinale Lin.*).Benguet State University, La Trinidad, Benguet.

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ABSTRACT

The effects of the different application rates of vermicompost on the performance of watercress was conducted at the BSU Organic demo farm, Benguet State University, La Trinidad, Benguet from November 2011 to February 2012. Specifically, the study aimed to evaluate the effects of different rates of vermicompost on the yield performance and return on cash expense of growing watercress and to evaluate the effect of the application of vermicompost fertilizer on some chemical properties (pH, OM and N-contents) of the soil.

The yield of watercress was not influenced by the different application rates of vermicompost. The dry matter yield of watercress on the other hand was affected by the application rates of vermicompost.

Increasing rates of application from 5 to 20 t ha^{-1} of vermicompost affected the soil chemical properties. Application of 20 t ha^{-1}vermicompost gave the highest mean for soil pH, %OM and Total N.

Application of 20, 15 and 5 t ha^{-1}vermicompost gave high returns on cash expense by 105.32%, 92.91% and 91.29%, respectively.

INTRODUCTION

Watercress (*Nasturtiumofficinale Lin.*) is an aquatic plant that thrives with its roots in water and its leaves in the sun. It is an aquatic, hardy perennial with succulent, hollow branching stems. The creeping or floating stems root easily and bear fleshy, shiny, heart-shaped leaves. The leaves are very dark green or bronze, with a distinctive peppery taste. It is also tolerant to frost (Fennell, 2006).

Watercress belongs to brassicaceae family. It is known to the Philippines as "Lampaken" and in Benguet, as "tongsoy". It originated from western Asia but is cultivated in Europe, United States and some parts of Asia. When traced back from the ancient times, watercress were used by the Greeks, Romans and Persians for medical purposes, as treatment for insanity (with vinegar), as a stimulant, and as a breath freshener.

It is high in potassium, Vitamins A, C, and E, iron, folic acid, and calcium. It also contains vitamin B_6 which helps get blood glucose into normal level and even manganese which is also helpful for women with osteoporosis problems.

The increase of productivity has always been the primary concern in every agricultural and rural development efforts. Various methods and technology systems has been employed and looked into as possible solutions to ensure high yields. However, these methods are not always the best solutions. Most of them come at a certain price. Certain techniques employed in ensuring high yields require high agricultural inputs such as fertilizers and pesticides. These imposed additional cost that burdens small farmers. The use of chemical fertilizers and pesticides tend to strip the soil of its natural nutrients, thereby causing environment to degrade (Lim, 2002).

Due to its economic and health importance, watercress production must be encouraged for small farmers for additional income. This must be done through the organic way of farming.

This study then serves as a guide for organic growers in the use of appropriate and effective organic fertilizers as well as the proper management techniques in the production of watercress without degrading the environment while sustaining agricultural production.

The study focused on the effects of different application rates of vermicompost on the performance of watercress *(Nasturtium officinale Lin)*.

Specifically, the study was conducted to 1) evaluate the effects of different rates of vermicompost on the yield performance and return on cash expense of growing watercress and 2) evaluate the effect of the application of vermicompost fertilizer on some chemical properties (pH, OM and N-contents) of the soil.

The study was conducted at the Organic Demo Farm experimental area, Department of Soil Science, College of Agriculture, Benguet State University La Trinidad Benguet from November 2011 to February 2012.

REVIEW OF LITERATURE

Importance of Growing Watercress

Orwell (2011) said that watercress contains gluconasturin, a unique type of phytochemical that is converted into PEITC (2- phenyl ethyl isothiocyanate), a volatile compound sensitive to heat and moisture and is found to inhibit the growth of a number of different kinds of cancer including breast cancer, colon, and prostate cancers.

In addition, the BBC website as cited by Bramwell (2010) reported that a study published in American Journal of Clinical Nutrition found that eating watercress reduces DNA damage in white blood cells.

Conventional Agriculture

Eicher(2003) defined Conventional agricultureasan industrialized agricultural system characterized by mechanization, monocultures, and the use of synthetic inputs such as chemical fertilizers and pesticides, with an emphasis on maximizing productivity and profitability.

In these modern times, agriculture is becoming more and more dependent upon the steady supply of artificial fertilizers and pesticides with the introduction of green revolution techniques (Singh, 2009). However, these conventional farming which our farmers had adopted brought lots of negative effects to the different aspects of human life. Panganiban (2006) as cited by Macaroy (2007) also said that over the last years, the reckless use of resources and the dependence on chemical based pesticides and fertilizers had harmful and possibly permanent effects on the environment.

The persistent use of chemical fertilizers causes the pollution of ground water sources, or leaching. They are highly soluble being absorbed by the ground more rapidly than the intended plants. Plants have the capacity to absorb only a given level of nutrition at a time leaving the rest of the fertilizer to leach. Leaching is not only hazardous to groundwater sources but also to the health of subsoil where these chemicals react with clay to create hard layers of soil known as hardpan (Sarfaras, 2011).

The synthetic chemicals in the chemical fertilizers adversely affect the health of naturally found soil micro-organisms by affecting the soil pH. These altered levels of acidity in the soil eliminate the micro-organisms beneficial to plant and soil health as they help to increase the plants' natural defenses against pests and diseases. The use of chemical fertilizers affects the health of bacteria that fix the nitrogen balance in the soil (Sarfaras, 2011).

Given this picture, going back to Organic Agriculture which had long been practiced in the olden times should be the priority of today's agriculture. The use of sustainable practices which ensures high productivity and profitability without degrading the environment must be taken into consideration.

Organic Agriculture

Organic Agriculture is a type of farming system that promotes the use of renewable resources and management of biological cycles to enhance biological diversity without the use of genetically modified organisms or synthetic pesticides, herbicides and fertilizers for the production of plants as well as the refrain from using synthetic food stuffs, growth hormones and antibiotics for the production of animals (Eicher, 2003).

It is also defined by the USA's National Organic Standards Board (1996) as cited by Balaoing (2010) as an ecological production management system that promotes and enhances biodiversity, biological cycles and soil biological activities.

IFOAM(2005) as cited by Asian Development Bank Institute (2011) defines organic agriculture as a "holistic production management system which promotes and enhances agro-ecosystem health, including biodiversity, biological cycles, and soil biological activity. It emphasizes the use of management practices in preference to the use of off-farm inputs, taking into account that regional conditions require locally adapted systems."

Organic production relies on management techniques that maintain and replenish the long term soil fertility by optimizing the soil's biological activity. These are achieved through crop rotation, cover cropping, use of compost and any organically accepted fertilizers that feed the soil while providing the plants with nutrients (Guerena, 2006).

Environmental Benefits of Organic Agriculture

Organic farming protects our water supply in a way that it bans artificial fertilizers to pollute water supply, it preserves healthy soils, prevents biodiversity loss, supports sustainable practices, saves energy and less fossil fuels, it also nurtures and protects wildlife and lastly, it helps maintain our rural communities in a way that organic farmers are independent and small in size that represents one of the few readily available and viable strategies for the survival of rural communities (Balaoing, 2010).

Food and Agriculture Organization (2011) also said that organic agriculture benefits the soil by encouraging soil fauna and flora thus improving soil formation and structure and creating more stable systems. In turn, nutrient and energy cycling is increased and the retentive abilities of the soil for nutrients and water are enhanced, compensating for the non-use of mineral fertilizers. Greater biodiversity which is employed in organic agriculture enhances soil structure and water infiltration. Properly managed organic systems with better nutrient retentive abilities greatly reduce the risk of groundwater pollution.

Organic agriculture as well reduces non-renewable energy use by decreasing agrochemical needs. It contributes to mitigating the greenhouse effect and global warming through its ability to sequester carbon in the soil. Many management practices used by organic agriculture increase the return of carbon to the soil, raising productivity and favoring carbon storage. The impact of organic agriculture on natural resources favors interactions within the agro-ecosystem that is vital for both agricultural production and nature conservation. Ecological services derived include soil forming and conditioning, soil stabilization, waste recycling, carbon sequestration, nutrients cycling, predation, pollination and habitats. By opting for organic products, the consumer through his/her purchasing power promotes a less polluting agricultural system. The hidden costs of agriculture to the environment in terms of natural resource degradation are reduced.

Benefits of Adding Organic Matter to the Soil

Organic matter is a reservoir of nutrients that can be released to the soil. Each percent of organic matter in the soil releases 20-30 pounds of N, 4.5-6.6 pounds of $P_2 O_5$ and 2-3 pounds of sulfur per year. Organic matter also absorbs and holds up to 90% of its weight in water which is released for plant absorption. It causes soil to clump and form aggregates which improves soil structure. With better soil structure, permeability improves in turn, improving the soils ability to take up and hold water. Lastly, organic matter prevents erosion (Funderburg, 2011).

MacRae and Mehuys (1990) added that organic matter plays more of a role in aggregate stability than in aggregate formation. It is, in fact, the primary stabilizing agent for aggregates in temperate-area soils. This stabilization process is accomplished mainly through the by-products of organic matter decomposition (microbial gums and mucilages). Organic matter also decreases the bulk density of soil.

The humus added to soil by organic fertilizers helps stabilize soil aggregates, improving tilth. It helps separate the particles in clay soil, which makes the soil looser and easier to work as well as easier for roots to penetrate. In sandy soil, humus acts as a binder to hold particles together so they don't wash away from the plants' roots, and it improves moisture retention. Humus and compost condition the soil, adds nutrients and improves the water retention properties. Healthy, organic soil has sponge-like properties that enhance the movement of water through the soil. Increased soil moisture aids microbes as they convert nutrients into a form plants can use, and it keeps those nutrients suspended so they are readily available for uptake by plants' root systems. Organic fertilizers supply natural sources of nutrients that microbes can process easily (Fischer, 2010).

Vermi Compost

Sundaram Overseas Operation (2008) said that vermi compost enriches the soil in most natural organic manner and also increases the quality, fertility and mineral content of the soil. As compared to chemical fertilizers, organic fertilizer is completely harmless and provides rich organic soil that is best for plants while chemical fertilizers destroy beneficial microorganisms. In addition, vermi compost contains more than eight kinds of useful microbial bacterium groups (over 600 million per gram) wherein it can supply all nutrition elements needed by variety of plants.

Liquid Organic Fertilizer

Zulueta (1982) as cited by Tomin (2011) said that Liquid organic fertilizers play an important role in plant growth particularly leafy vegetable crops. It gives a very important source of mineral elements and food for the plant. It has been extensively used in irrigated lands for direct application to crops.

Organic Products

Organic crops differ in nutrient content from conventional crops. Organic crops contained significantly more vitamin C, iron, magnesium, and phosphorous and significantly less nitrates. These were significant trends showing less protein but of a better quality and higher content of nutritionally significant minerals with lower amounts of some heavy metals in organic crops compared to conventional ones (Worthington, 2001).

MATERIALS AND METHODS

The materials used in the research experiment were stem cuttings of watercress of similar length (3 inches) and maturity, vermicompost which was obtained from the BSU Organic Demo Farm, liquid organic fertilizer derived from 13 kg chopped banana trunk; 13 kg chopped wild sun flower and 1 L molasses fermented for 7-10 days, identifying tags which was used for treatment identification and farm implements such as sickle, cultivator, and hoes.

A total land area of 50 m^2 was thoroughly prepared following watercress culture production. Puddling the soil for the purpose of water conservation and maintenance is necessary to grow watercress in the area. The area was divided into four (4) blocks with each block having five (5) treatment plots measuring 1mx2m each. Border plot of at least 1 foot width was used to separate each treatment to avoid contamination. Each treatment was planted with 2 kg of watercress stem cuttings after the application of vermicompost following the different rates studied.

Application of the different amounts of vermicompost were done by thoroughly incorporating this a week before planting.

Blanket application of liquid organic fertilizer of about 500 ml diluted LOF derived from fermented 13 kg chopped banana trunk, 13 kg chopped wild sunflower and 1 L molasses was applied 1 week after planting at an interval of 7 days.

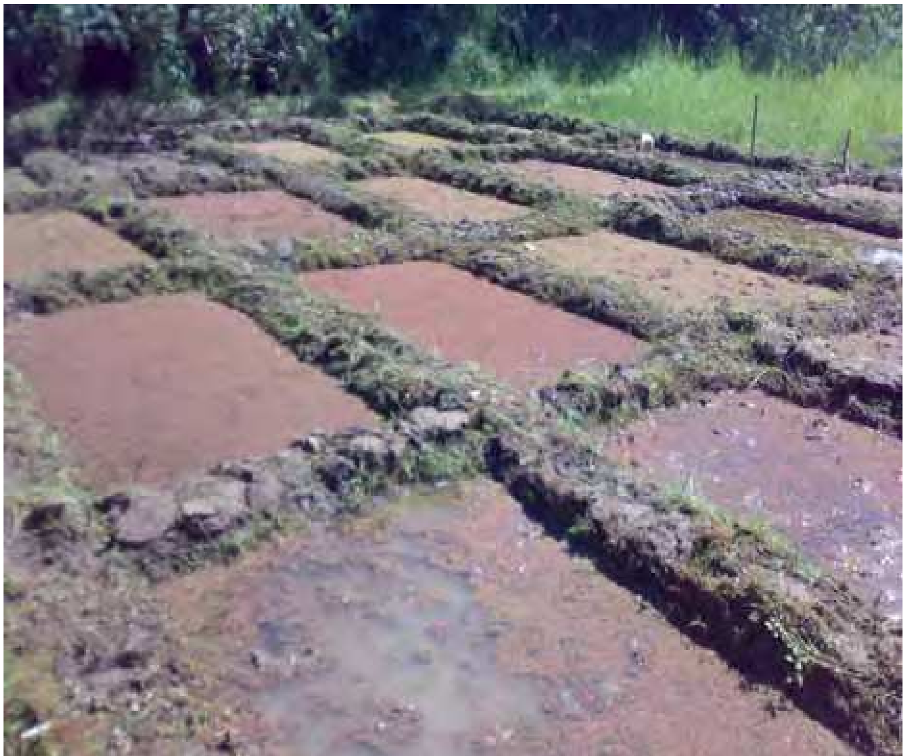

Figure 1. Field layout of the experimental area located at the BSU organic demo farm, La Trinidad, Benguet

Figure 2. Fermented chopped sunflower, banana trunk and molasses as liquid organic fertilizer

The following treatments studied were as follows:

C_1 = No fertilizer input + Liquid Organic Fertilizer

C_2 = 5 tons/ha vermicompost + Liquid Organic Fertilizer

C_3 = 10 tons/ha vermicompost + Liquid Organic Fertilizer

C_4 = 15 tons/ha vermicompost + Liquid Organic Fertilizer

C_5 = 20 tons/ha vermicompost + Liquid Organic Fertilizer

The different treatments were laid out in the experimental area following the Randomized Complete Block Design (RCBD) with four (4) replications.

The data gathered were:

1. Fresh weight of water cress at harvest

Staggered harvesting of watercress was done throughout the conduct of the study. This was marketed into one-fourth (1/4) kg or 250 g labeled as organic product at the BSU Organic Market.

2. Dry matter yield

This was gathered by weighing twenty grams of watercress separately for each treatment and was cut into pieces. It was oven dried for 24 hours. This was recorded and computed using the following formula:

$$\text{Dry matter} = 100\% - \%\ \text{Moisture Content}$$

$$\text{Where: } \%\ \text{Moisture Content} = \frac{FW - ODW}{ODW} \times 100$$

3. Insect Pest Incidence

The plants were observed and the occurrence of insect pests was noted. The insects that attacked the watercress and the damage they caused was monitored and recorded. The arbitrary rating scale used by Halog and Molina (1981) is shown below.

Scale	Description
1	Sound, leaves with no damage
2	Slight, 1-3 leaves affected
3	Moderate, 4-6 leaves affected
4	Severe, most of the leaves affected
5	Skeletonized, all leaves affected

4. Disease Incidence

The plants were observed and the occurrence of diseases was recorded. Diseases were rated using the arbitrary rating scale used by Lasilas, (2010) asshown below.

Scale	Description
1	No infection
2	1-25% of the total plant
3	26-50% of the total plant
4	51-71% of the total plant
5	76-100% of the total plant

5. Soil Analysis- Soil samples were collected before planting and after harvest for the following analysis using PCCARD standard method:

a. Soil pH. This was determined using 1:2.5 $CaCl_2$ soil suspension. A 10 g of air dried soil was weighed into a 100 ml beaker. Then 25 ml of 0.01 M $CaCl_2$ was added and stirred thoroughly and periodically for 15 to 20 minutes. The pH meter was calibrated with the standard buffer solution. The electrode of pH meter reading was recorded.

b. Organic matter content of the soil (%). One gram of oven dried soil was placed in a 250 ml conical flask. Then 10 ml of 1N $K_2 Cr_2 O_7$ was added followed by an immediate and rapid addition of concentrated H_2SO_4. The soil solution was mixed gently and it was allowed to be digested in the fume hood. After digestion, 250 ml of distilled water was added. Concentrated H_3BO_3 and 1.0 ml of diphenylamine indicator solution was added to the filtrate. The solution was titrated with standard 0.5 N $FeSO_4$. Titration was stopped when the initial color of yellowish brown changed from blue to violet to green abruptly. The green color indicated the end point. A blank sample was prepared following the same procedure except that no soil will be added. The % Organic matter was computed using the formula:

$$\% \text{ OM} = \frac{10}{S}(S-T) \times 0.0069 \times \frac{100}{\text{wt. of soil sample}}$$

Where S = ml of ferrous solution required for blank

T = ml of ferrous solution required for sample

c. Nitrogen Content of the Soil (%). The Nitrogen content of the soil was computed by multiplying the OM content by 0.05.

6. Return on Cash Expenses

This was done by recording all the expenses and production rates. It was computed using the formula;

$$\text{ROCE (\%)} = \frac{\text{Gross income} - \text{Total Expenses}}{\text{Total Expenses}} \times 100\%$$

RESULTS AND DISCUSSION

Yield of Parameters of Watercess as Affected by
the Different Application Rates
ofVermicompost

Yield per Plot

Table 1 shows the watercress yield per plot as affected by the different rates of vermicompost. There were no significant differences obtained in the analysis. However, plant grown from those applied with 20 t ha^{-1}vermicompost had the highest yield of 4.14 kg per plot. Untreated plots registered the lowest yield of 3.033 kg per plot. This implies that application of vermicompost enhances yield of watercress.

Dry Matter Yield

The dry mater yield of watercress as affected by the different application rates of vermicompost is shown in Table 2. Plants grown from those applied with 20 t ha^{-1}, 15

Table 1. Yield per plot as affected by the different application rates of vermicompost.

TREATMENT	MEAN
C_1 = Control	3.033^a
C_2 = 5tons/ha VC + LOF	3.405^a
C_3 = 10tons/ha VC + LOF	3.155^a
C_4 = 15tons/ha VC + LOF	3.743^a
C_5 = 20 tons/ha VC + LOF	4.148^a

Means followed by a common letter / s in a column are not significantly different at 0.05 level by DMRT.

t ha^{-1} and 10 t ha^{-1}vermicompost had the highest mean of 8.55 g, 7.225g, and 7.705 g respectively. Plants grown from those untreated plots gave the lowest mean of 4.725 g. The result implies that application of vermicompost enhances the dry matter yield of watercress. This confirms the study of Azarmi*et. al.* (2008) wherein application of vermicompost at the rate of 15 t ha^{-1} increases the dry matter yield of tomato fruit by 24%.

Pest Infestations as Affected by the Different Application Rates ofVermicompost

Snail Infestation

Table 3 shows the ratings of snail infestations of watercress as affected by the different application rates of vermicompost. Plants treated with 10 t ha^{-1} vermicompost

Table 2.Dry matter yield of watercress as affected by the different application rates of vermicompost.

TREATMENT	MEAN
C_1 = Control	4.725^{bc}
C_2 = 5tons/ha VC + LOF	6.625^{b}
C_3 = 10tons/ha VC + LOF	7.705^{a}
C_4 = 15tons/ha VC + LOF	7.225^{a}
C_5 = 20 tons/ha VC + LOF	8.550^{a}

Means followed by a common letter / s in a column are not significantly different at 0.05 level by DMRT.

significantly had the highest rate of 3.75 snail infestation. Lowest rate of snail infestation was noted from those plants applied with 5 t ha^{-1}vermicompost.

Flee Beetle Infestation

Flee Beetle infestation as shown in Table 3 showed that highest rate of 2.25 (Slight damage) snail infestation was observed from untreated plots while lowest rate of 1.125 (no damage) was noted from plants applied with 20 t ha^{-1}vermicompost.

Cabbage Worm

Cabbage worm infestation (Figure 3) showed no significant differences (Table 3). However, highest rate of infestation which is 1.186 (no damage) was observed from plants treated with 5 t ha^{-1}vermicompost and the lowest rate which is 1 (no damage) was noted from both plants applied with 15 t ha^{-1} and 20 t ha^{-1} vermicompost.

Table 3.Pest infestations of watercress as influenced by the different application rates of vermicompost.

TREATMENT	RATE OF PEST DAMAGE		
	SNAIL	FLEEBEETLE	CABBAGE WORM
C_1 = Control	1.50^{bc}	2.25^{a}	1.125^{a}
C_2 = 5tons/ha VC + LOF	1.25^{b}	1.375^{a}	1.186^{a}
C_3 = 10tons/ha VC + LOF	3.75^{a}	1.438^{a}	1.125^{a}
C_4 = 15tons/ha VC + LOF	1.75^{b}	1.375^{a}	1.000^{a}
C_5 = 20 tons/ha VC + LOF	2.00^{b}	1.125^{a}	1.000^{a}

Means followed by a common letter / s in a column are not significantly different at 0.05 level by DMRT.

Disease Incidence of Watercress as Affected by the Different Application Rates ofVermicompost

Aster Yellow Infection

Statistics revealed no significant differences in the infestation of aster yellow disease of watercress (Figure 3) as influenced by the different application rates ofvermicompost (Table 4). However, highest rate of infestation were observed from untreated plants, plants applied with 5 t ha^{-1}, and 15tons ha^{-1}vermicompost having a mean of 1.75%. Lowest rate of 1.25% was noted from plants applied with 20 t ha^{-1}vermicompost. Aster yellow is one among the serious diseases of watercress production (McHugh, 2012).

Table 4. Aster yellow disease of watercress as affected by the different application rates of vermicompost.

TREATMENT	MEAN
C_1 = Control	1.75^{a}
C_2 = 5tons/ha VC + LOF	1.75^{a}
C_3 = 10tons/ha VC + LOF	1.50^{a}
C_4 = 15tons/ha VC + LOF	1.75^{a}
C_5 = 20 tons/ha VC + LOF	1.25^{a}

Means followed by a common letter / s in a column are not significantly different at 0.05 level by DMRT.

Figure 3. Aster yellow disease and cabbage worm infestation

Some Chemical Properties of the Soil

Initial Properties of the Soil

The initial properties of the soil were analyzed before planting (Table 5). The initial pH of the soil was 5.7 indicating that the soil is slightly acidic. The nitrogen content and organic matter content were 0.12% and 2.56% respectively. The initial pH of the soil is low in terms of the favorable soil pH for watercress production which is neutral or 7.0 (McHugh, 2012). Organic matter content on the other hand is slight low and it did not reach the range for mineral surface soils which is 3-5% by weight (Brady, 1985). This implies that application of organic fertilizer is necessary to supplement the soil.

Table 5.Initial Soil Properties.

PROPERTY	CONTENT
A. Chemical Properties	
1. pH	5.7
2. N (%)	0.12
3. OM (%)	2.56

Final Soil pH

Table 6 shows the final pH of the soil as affected by the different application rates of vermicompost. An increase on the soil pH was noted from vermicompost application from the initial soil pH of 5.7. Plots applied with 5, 10, 15 and 20 t ha^{-1} vermicompostgave corresponding increases of 17.37%, 17.54%, 21.58%, and 26.00% respectively overthe initial pH value of 5.70. Likewise an increase of 14.04% was observed from plots without vermicompost application. The observation can be attributed to the ability of the organic material to buffer changes in soil pH.

Organic Matter Content of the Soil

Organic matter content of the soil was influenced by the application rates of vermicompost (Table 7). There were observed increase of the organic matter contents of the soil where vermicompost was applied from 5 to 20 t ha^{-1} over the initial value of 2.56%.

Moreover, statistical analysis showed highly significant differences among the treatments. Plots applied with 20, 15, 10, and 5 t ha^{-1}vermicompost differ at about 98.47%, 97.55%, 89.26%, and 53.68% respectively over the control. An increase in theOM content in the control plots as compared to the initial (2.56%) could be attributed to the blanket application of Liquid organic fertilizer. Results implied that increasing the rate of application for vermicompost increases the organic matter content of the soil. Arancon and Edwards (2005) said that the application of vermicompost in the field enhances the quality of soils by increasing microbial activity and microbial biomass which are key components in nutrient cycling, production of plant growth regulators and protecting plants soil-borne disease and arthropod pest attacks.

Table 6. Soil pH as affected by the different application rates of vermicompost.

TREATMENT	MEAN
C_1 = Control	6.50^{e}
C_2 = 5tons/ha VC + LOF	6.70^{d}
C_3 = 10tons/ha VC + LOF	6.70^{c}
C_4 = 15tons/ha VC + LOF	6.93^{b}
C_5 = 20 tons/ha VC + LOF	7.00^{a}
Initial	5.70

Means followed by a common letter /s in a column are not significantly different at 0.05 level by DMRT.

Table 7.Organic matter content of the soil as affected by the different application rates of vermicompost.

TREATMENT	MEAN
C_1 = Control	3.26^{c}
C_2 = 5tons/ha VC + LOF	5.01^{c}
C_3 = 10tons/ha VC + LOF	6.17^{b}
C_4 = 15tons/ha VC + LOF	6.44^{a}
C_5 = 20 tons/ha VC + LOF	6.47^{a}
Initial	2.56

Means followed by a common letter / s in a column are not significantly different at 0.05 level by DMRT

Total Nitrogen Content of the Soil

Total nitrogen of the soil was influenced by the application of different rates of vermicompost (Table 8). Application of increasing rates of vermicompost affected thetotal nitrogen content of the soil as compared to the initial which is 0.12%. An increase of 33.33%, 116.67%, 158.33%, 166.67% and 191.67% was observed from plots treated with 5, 10, 15 and 20 t ha^{-1}vermicompost respectively.

Likewise, application of 20, 15, 10, and 5 t ha^{-1}vermicompost differ at about 118.75%, 100%, 93.75% and 62.50% respectively over the control.

An increase in the total nitrogen in the untreated plants having 0.16% as compared to the initial (0.12%) could be attributed to the blanket application of liquid

Table 8.Total Nitrogen content of the soil as affected by the different application rates of vermicompost.

TREATMENT	MEAN
C_1 = Control	0.16[c]
C_2 = 5tons/ha VC + LOF	0.26[c]
C_3 = 10tons/ha VC + LOF	0.31[b]
C_4 = 15tons/ha VC + LOF	0.32[a]
C_5 = 20 tons/ha VC + LOF	0.35[a]
Initial	0.12

Means followed by a common letter / s in a column are not significantly different at 0.05 level by DMRT

organic fertilizer. This implies that increasing rates of vermicompost increases total nitrogen of the soil.

Economic Importance

Return on Cash Expenses

The return on cash expenses of watercress as affected by the different application rates of vermicompost is shown in Table 9. Plants applied with 20 tha^{-1}vermicompost gave the highest ROCE of 105.32%. This implies that for every 1 peso investment, there is a 105.32 return of investment. Plots applied with 15 and 5 tha^{-1}vermicompost on the other hand have a peso investment return of 92.91 and 91.29 respectively. Lowest ROCE was noted from untreated plants and plants applied with 10 tha^{-1}vermicompost having 78.38% and 69.62% respectively.

Plots applied with 10 t ha^{-1} which has the lowest ROCE was attributed to the attack of snails which had caused major damage to the plants as shown in Table 7.

Table 9. Cost and return analysis of watercress applied with the different application rates of vermicompost.

TREATMENT	Yield /2m² (kg)	GROSS INCOME (Php)	COST OF PRODUC-TION (Php)	NET INCOME (Php)	%ROCE
C_1	12.13	1,213	680	533	78.38
C_2	13.62	1,362	712	650	91.29
C_3	12.62	1,262	744	518	69.62
C_4	14.97	1,497	776	721	92.91
C_5	16.59	1,659	808	851	105.32

Price was computed at Php100/kg.

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The study was conducted at the BSUOrganic Demo Farm, Benguet State University, La Trinidad, Benguetfrom November 2011 to February 2012.The study was conducted to: 1) to evaluate the effects of different rates of vermicompost on the yield performance and return on cash expense of growing watercress and 2) to evaluate the effect of the application of vermicompost fertilizer on some chemical properties (pH, OM and N-contents) of the soil.

The different application rates of vermicompost did not influence the total yield of watercress. However, the dry matter yield of watercress was affected by the application of vermicompost.

The initial soil pH was increased with the increasing rates of vermicompost to a favorable pH for watercress production. Percent OM and total N content of the soil however, is at the optimum level and it is most likely sufficient for plant growth. Application of vermicompost tend to increase these soil chemical properties because plants treated with the highest rate of vermicompost gave the highest value for soil pH and both % OM and % N.

The return on cash expense (ROCE) showed that high returns were obtained from plants grown in plots applied with 20, 15 and 5 tons ha^{-1}vermicompost having 105.52%, 92.91% and93.29%respectively.

Conclusion

Based on the results of the experiment, the following conclusions were drawn:

1. Increased application rates of vermicompost influenced the chemical properties of soil studied thus is effective in increasing the yield of watercress. However, the yield increase based on the different application rates of vermicompost was not significant.

2. Vermicompostapplication of 5, 15 and 20 t ha^{-1} gave high economic benefits compared to the control.

Recommendation

Application of either 20 tha^{-1} or 15 tha^{-1}vermicompost is recommended as best application rates for growing watercress. Further study however is recommended to verify the results.

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APPENDICES

Appendix Table 1. Yield per plot (kg/2m^2)

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
C_1	1.45	4.28	3.51	2.89	12.13	3.033
C_2	4.37	3.63	2.13	3.49	13.62	3.405
C_3	3.28	2.36	2.80	4.18	12.62	3.155
C_4	3.34	4.62	3.45	3.56	14.97	3.743
C_5	3.72	5.01	4.35	3.51	16.59	4.148
TOTAL	16.16	19.9	16.24	17.63	69.93	17.484

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	0.01
BLOCK	3	1.83	0.61			
TREATMENT	4	3.30	0.825	1.06^{ns}	3.26	5.41
ERROR	12	9.34	0.778			
TOTAL	19	14.47	2.21			

ns - Not Significant %CV= 5.04

Appendix Table 2. Dry matter yield (g)

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
C_1	4.4	4.5	4.9	5.1	18.9	4.725
C_2	6.3	8.4	6.0	5.8	26.9	6.625
C_3	8.7	5.7	7.2	6.6	28.2	7.050
C_4	5.7	8.1	8.0	7.1	28.9	7.225
C_5	9.1	8.3	8.6	8.2	34.2	8.550
TOTAL	34.2	35	34.7	32.8	137.1	34.175

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	0.01
BLOCK	3	0.574	0.191			
TREATMENT	4	30.55	7.638	7.03**	3.26	5.41
ERROR	12	13.05	1.087			
TOTAL	19	44.17	8.916			

**- Highly Significant %CV= 3.05

Appendix Table 3. Snail's infestation on watercress

TREATMENT	BLOCK				TOTAL	MEAN
	I	II	III	IV		
C_1	1	2	2	1	6	1.50
C_2	1	1	2	1	5	1.25
C_3	2	5	4	3	15	3.75
C_4	1	3	1	2	7	1.75
C_5	2	2	1	3	8	2.00
TOTAL	8	13	10	10	41	10.25

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
BLOCK	3	2.55	0.85			
TREATMENT	4	15.7	3.93	7.02**	3.26	5.41
ERROR	12	6.7	0.56			
TOTAL	19	44.17	5.34			

**- Highly Significant %CV= 7.30

Appendix Table 4. Flee Beetle infestation on watercress

TREATMENT	BLOCK				TOTAL	MEAN
	I	II	III	IV		
C_1	2.00	1.75	2.00	1.00	6.75	2.250
C_2	1.75	1.00	1.25	1.50	5.50	1.375
C_3	1.00	2.00	1.75	1.00	5.75	1.438
C_4	1.75	1.00	1.00	1.75	5.50	1.375
C_5	1.00	1.50	1.00	1.00	4.50	1.125
TOTAL	7.50	7.25	7.00	6.25	28.00	7.563

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
BLOCK	3	0.175	0.058			
TREATMENT	4	0.644	0.161	0.82^{ns}	3.26	5.41
ERROR	12	2.356	0.196			
TOTAL	19	44.17	0.415			

ns - Not Significant %CV= 5.85

Appendix Table 5. Cabbage worm infestation on watercress

TREATMENT	BLOCK				TOTAL	MEAN
	I	II	III	IV		
C_1	1	1	1	1.5	4.5	1.125
C_2	1	1	1	1.75	4.75	1.186
C_3	1	1	1	1.5	4.5	1.125
C_4	1	1	1	1	4	1.00
C_5	1	1	1	1	4	1.00
TOTAL	5	5	5	6.75	21.75	5.436

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
BLOCK	3	0.463	0.154			
TREATMENT	4	0.116	0.029	1.04^{ns}	3.26	5.41
ERROR	12	0.334	0.028			
TOTAL	19	0.913	0.211			

ns - Not Significant %CV= 3.08

Appendix Table 6. Aster yellow disease infestation on watercress (%)

TREATMENT	BLOCK				TOTAL	MEAN
	I	II	III	IV		
C_1	1	2	1	3	7	1.75
C_2	1	2	2	2	7	1.75
C_3	1	1	1	3	6	1.50
C_4	1	2	1	3	7	1.75
C_5	1	1	2	1	5	1.25
TOTAL	5	8	7	12	32	8

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
BLOCK	3	5.2	1.73			
TREATMENT	4	0.8	0.20	0.5^{ns}	3.26	5.41
ERROR	12	4.8	0.40			
TOTAL	19	44.17	2.30			

ns - Not Significant %CV= 8.84

Appendix Table 7. Soil pH

TREATMENT	BLOCK I	II	III	IV	TOTAL	MEAN
C_1	6.55	6.43	6.54	6.46	25.98	6.495
C_2	6.73	6.72	6.65	6.67	26.77	6.693
C_3	6.73	6.67	6.71	6.70	26.81	6.703
C_4	6.76	7.01	6.96	6.98	27.71	6.928
C_5	6.93	7.00	7.08	6.97	27.98	6.995
TOTAL	33.7	33.83	33.94	33.78	135.25	33.813

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	0.01
BLOCK	3	0.0042	0.0014			
TREATMENT	4	0.6435	0.1609	30.36**	3.26	5.41
ERROR	12	0.0634	0.0053			
TOTAL	19	0.711	0.1676			

** Highly Significant %CV= 0.21

Appendix Table 8. Organic matter content of the soil (%)

TREATMENT	BLOCK				TOTAL	MEAN
	I	II	III	IV		
C_1	3.08	3.18	3.38	3.28	13.02	3.26
C_2	4.47	5.86	5.26	4.96	20.05	5.01
C_3	6.25	6.06	6.16	6.21	24.68	6.17
C_4	6.50	6.40	6.42	6.43	25.75	6.44
C_5	6.21	6.55	6.75	6.35	25.86	6.47
TOTAL	26.61	28.05	27.97	33.78	109.36	27.35

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F	
					0.05	0.01
BLOCK	3	0.362	0.121			
TREATMENT	4	30.72	7.532	73.126**	3.26	5.41
ERROR	12	1.241	0.103			
TOTAL	19	32.323	7.756			

**- Highly Significant %CV= 1.17

Appendix Table 9. Total nitrogen content of the soil (%)

TREATMENT	BLOCK				TOTAL	MEAN
	I	II	III	IV		
C_1	0.16	0.16	0.17	0.16	0.65	0.16
C_2	0.22	0.29	0.26	0.25	1.02	0.26
C_3	0.31	0.30	0.31	0.31	1.23	0.31
C_4	0.33	0.32	0.32	0.32	1.29	0.32
C_5	0.31	0.33	0.38	0.32	1.34	0.35
TOTAL	1.33	1.40	1.44	1.36	5.53	1.40

ANALYSIS OF VARIANCE

SOURCE OF VARIANCE	DEGREE OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
BLOCK	3	0.001	0.0003			
TREATMENT	4	0.080	0.0200	50.00**	3.26	5.41
ERROR	12	0.005	0.0004			
TOTAL	19	0.086	0.0207			

** - Highly Significant %CV= 1.43

Appendix Table 10. Return on cash expenses

TREATMENT	Yield /Plot (kg)	GROSS INCOME (Php)	COST OF PRODUC-TION (Php)	NET INCOME (Php)	%ROCE
C_1	12.13	1,213	680	533	78.38
C_2	13.62	1,362	712	650	91.29
C_3	12.62	1,262	744	518	69.62
C_4	14.97	1,497	776	721	92.91
C_5	16.59	1,659	808	851	105.32

Price used in the computation of gross income is Php 100.

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