BIBLIOGRAPHY

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ABSTRACT

Performance of cabbage (var. Scorpio) applied with vernicompost under protected environment was conducted at the BSU Organic Demonstration Farm, Benguet State University, La Trinidad, Benguet from November 2011 to March 2012. Specifically, the study was conducted to: determine the best rate of vermicompost on the growth of cabbage (var. Scorpio) under protected environment, determine the best rate of vermicompost application on the yield of cabbage (var. Scorpio), determine the effect of vermicompost on some physical and chemical properties of the soil, and determine the economic benefit of growing cabbage (var. Scorpio) grown in soils applied with vermicompost under protected environment.

The dry matter yield (DMY), solidity and yield of cabbage (var. Scorpio) were improved by different rates of vermicompost application under protected environment.

The application of different rates of vermicompost influenced some physical and properties of the soil studied. Application of 10 to 25 tons ha^{-1} significantly increased the water holding capacity (WHC), porosity of the soil and decreased the bulk density.

On the other hand, the pH, OM and N contents of the soil were influenced by vermicompost application. Higher pH values of the soil were obtained from the application of 10 to 25 tons ha^{-1} vermicompost. The OM and N contents were highest in soil applied with 25 tons of vermicompost ha^{-1}.

Increasing the amount of vermicompost showed economic benefit when cabbage (var. Scorpio) was grown under protected environment.

RESULTS AND DISCUSSION

Agronomic Parameters

Dry matter yield.Application of different rates of vermicompost affected the dry matter yield (DMY) as shown in Table 1. Application of 10, 15, 20 and 25 tons ha^{-1}vermicompost influenced the dry matter yield which had increase of 41.30%, 38.32, 96.92% and 79.42%, respectively over the control. Application of 20 tons ha^{-1}registered the highest dry matter yield but not significantly different with 25 tons ha^{-1}. The control registered the lowest dry matter yield of 29.25%.

According to Patel *et al*. (1994) dry matter yield was increased and crude fiber contents were decreased with increased vermicompostapplication. Increased rate of vermicompostincreased the protein and digestible dry matter yield (Rana*et al*. 1990).

Table 1. Dry matter yield per plot as influenced by the different application rates of vermicompost

RATES OF VERMICOMPOST (tons ha^{-1})	DMY (%)
Control	9.75[c]
10	13.78[b]
15	13.49[b]
20	19.20[a]
25	17.49[a]

Means with the same letter/s are not significantly different at 5% level by DMRT.

Solidity. Table 2 shows high differences on the solidity of cabbage heads applied with different rates of vermicompost. Cabbage grown in plots applied with 10, 15, 20 and 25 tons ha^{-1} had corresponding increases of 127.20%, 165.85%, 165.85% and 172.62%, respectively over the control. Cabbage plants grown in plots applied with 15 tons ha^{-1} to 25 tons ha^{-1} produced the hardest cabbage heads compared with control. The results indicate that application of organic fertilizer and compost improves the quality of cabbage as reported by Blatt (1991), El-Shinawy *et al.,* (1999) and Premuzic *et al*., (2002).

Table 2. Solidity of cabbage head as influence by different application rates of vermicompost

RATES OF VERMICOMPOST SOLIDITY (tons ha^{-1})	HEAD
Control	1.47[c]
10	3.33[b]
15	3.90[a]
20	3.90[a]
25	4.00[a]

Means with the same letter/s are not significantly different at 5% level by DMRT

Total yield . Table 3 shows the influence of different rates of vermicompost on the yield of cabbage. Cabbage grown in plots applied with 25 tons ha^{-1}produced the highest yield (30.48/5.95m^2). This was followed by 20 tons ha^{-1}, 15 tons ha^{-1}, and 10 tons ha^{-1} with corresponding increases of 175.93%, 162.14%, and 83.75% over the control. As the rate of vemicompost was increased, the more the yield produced.

The increase in yield in cabbage can be attributed to the influence of vermicompost applied on the influence in the total physical, chemical and biological properties of the soil meeting the demands of greenhouse crops (Prabha *et al*.,2007 and Rodriguez *et al*.,2008). This further supported by the report of Castillo *et al*.(2002) that vermicompost in particular it increases soil fertility without polluting the soil, and further not only the quantity of harvested but also the quality of products.

Table 3. Total yield as influenced by different application rates of vermicompost

RATES OF VERMICOMPOST (tons ha^{-1}) $5.95m^{-2}$)	WEIGHT (kg
Control	5.67^{d}
10	10.43^{c}
15	13.95^{b}
20	14.87^{b}
25	30.48^{a}

Means with the same letter/s are not significantly different at 5% level by DMRT

Some Physical Properties

Water holding capacity of the soil . The water holding capacity of the soil as affected by the different application rates of vermicompost is shown in Table 4. Increasing the amounts of vermicompost to 10, 15, 20 and 25 tons ha^{-1} increased the water holding capacity by 4.56% 10.62%, 18.34% and 22.12%, respectively over the initial value of 58.28%. On the other hand , soils not applied with vermicompost decreased by 12.46 %

over the initial value. The increases on the moisture contents of the soil applied with different amounts can be attributed to the ability of the vermicompost in increasing the surface area, thus more water were retained in the soil (Edwards and Burrows, 1998; Shi – wei and Fu – zhen, 1991 and Edwards, 1983).

Table 4. Water Holding Capacity of the soil as influenced by different application rates of vermicompost

RATES OF VERMICOMPOST (tons ha^{-1})	WHC (%)
Control	51.02[e]
10	60.93[d]
15	64.47[c]
20	68.97[b]
25	72.17[a]
Initial	58.28

*Means with the same letter/s are not significantly different at 5% level by DMRT.

Bulk density of the soil. Table 5 shows the bulk density of the soil as affected by the different application rates of vermicompost. Application of vermicompost from 10 tons to 25 tons ha^{-1}influenced the bulk density of the soil. Bulk densities of plots applied with 25, 20, 15, and 10 tons ha^{-1} decreased the values at about 4.44%, 8.89%, 12.59% and 10.42 %, respectively over the control. This shows that increasing the rates of vermicompost application from 10 - 25 tend to decrease the bulk density of the soil. This reduction in soil bulk density can be due to the improved porosity as influenced by the granulation of the soil particles by the applied organic material (Bazzoffi *et al*., 1998).

Table 5. Bulk density (Db) of the soil as influenced by different application rates of vermicompost

RATES OF VERMICOMPOST (tons ha^{-1})	Db ($g\ cm^{-3}$)
Control	1.35^{a}
10	1.29^{b}
15	1.23^{bc}
20	1.18^{c}
25	1.21^{c}
Initial	1.34

Means with the same letter/s are not significantly different at 5% level by DMRT.

Porosity of the soil. Application of different rates of vermicompost influenced the porosity of the soil (Table 6). Application of vermicompost from 10 tons ha^{-1} to 25tons ha^{-1} increased the porosity of the soil from 5.72%, 8.74%, 16.83% and 15.31%, respectively over the initial value. This shows that as the rates of vermicompost application increased, the pore space tend to increase. The greater porosity in the soil applied with vermicompost can be due to an increase in the amount of rounded pores (Marinari *et al*., 2000). Pagliai *et al*. (1980) reported that the increase in porosity has been attributed to increased number of pores in the 30 - 50 µm and 50 - 500 size ranges and a decrease in number of pores greater than 500 µm when applied with vermicompost.

Table 6. Total Porosity of the soil as influenced by different application rates of vermicompost

RATES OF VERMICOMPOST (tons ha^{-1})	PORE SPACE (%)
Control	50.83^{e}
10	53.57^{d}
15	55.10^{c}
20	59.20^{b}
25	58.43^{ab}
Initial	50.67

Means with the same letter/s are not significantly different at 5% level by DMRT.

Some Chemical Properties

Soil pH. Table 7 shows that application of vermicompost from 10 to 25 tons ha^{-1} decreased the soil pH from an initial of 6.30 to a range of 5.35 to 5.52. Vermicomost applied at the rates of 10 to 25 tons ha^{-1} increased the pH of the soil from 18.41%, 15.08%, 13.97%, 13.49%, and 12.38%, respectively over the control. The production of $NH4^{+}$, CO2 and organic acids during microbial metabolism in vermicompost contributed to the decrease in soil pH (Albanell *et al*., 1988).

Table 7. Soil pH as influenced by different application rates of vermicompost

RATES OF VERMICOMPOST (tons ha^{-1})	Soil pH
Control	5.14[d]
10	5.35[c]
15	5.42[b]
20	5.45[b]
25	5.52[a]
Initial	6.30

*Means with the same letter/s are not significantly different at 5% level by DMRT.

Organic matter content. Increasing the rates of vermicompost applied in the soil increased the organic matter contents (Table 8). Application of 25 tons ha^{-1} registered the highest amount of organic matter which is 4.65% which significantly differed from the different rates of vermicompost. The results also shows that increasing the application rates of vermicompost from 10 to 25 tons ha^{-1} increased the organic matter content of the soil. The high OM content can be attributed to the high amount of vermicompost applied. The results imply that vermicompost is an excellent product being homogeneous, retaining most of the original nutrients and reduced level of organic contaminants, and can be applied to soil to increase soil organic matter content which can be released upon decomposition (Springer, 2012).

Table 8. Organic matter content of the soil as influenced by different application rates of vermicompost

RATES OF VERMICOMPOST (tons ha^{-1})	Organic matter (%)
Control	2.51[e]
10	2.68[d]
15	2.97[c]
20	3.52[b]
25	4.65[a]
Initial	1.94

*Means with the same letter/s are not significantly different at 5% level by DMRT.

Total nitrogen content of the soil. Table 9 shows the nitrogen content of the soil as influenced by the different rates of vermicompost application. Application of vermicompost from 10 to 25 tons ha^{-1} gave corresponding increase of Nitrogen content at about 66%, 96%, 103% and 113%, respectively over the initial value. The increase on the N – contents of the soil after application of vermicompost can be due to the quantity and quality of the nutrients in vermicomposts (Elvira *et al*,. 1996, Albanell *et al*., 1988, Cuevas, 1996, Businelli *et al.*, 1984, Edwards and Burrows, 1988 and Theunisseu *et al.*, 2010).

Table 9. Total Nitrogen content of the soil as influenced by different application rates of vermicompost

RATES OF VERMICOMPOST (tons ha^{-1})	Nitrogen (%)
Control	0.13[b]
10	0.13[b]
15	0.15[b]
20	0.18[ab]
25	0.23[a]
Initial	0.05

*Means with the same letter/s are not significantly different at 5% level by DMRT.

Economic Importance

Return on Cash Expenses. The return on cash expenses (ROCE) as affected by the different application rates of vermicompost is shown in Table 10. Application of 10 tons ha^{-1}, 15 tons ha^{-1}, 20 tons ha^{-1} and 25 tonsha^{-1}vermicompost gave a corresponding cash return of 228.25%, 290.85%,283.61% and 599.38%, respectively. The control on the other hand gave the lowest return of 4.18%. Plots treated with 25 tons ha^{-1}vermicompost had a high ROCE of 599.83% compared to the other treatments due to the high rate application of vermicompost.

Table 10. Return on cash expense of cabbage as influenced by different application rates of vermicompost

TREATMENT	Yield /Plot (kg/plot)	GROSS INCOME (Php)	COST OF PRODUC-TION (Php)	NET INCOME (Php)	%ROCE
Control	5.67	340.20	142.25	197.95	139.16
10 tons/ha	10.43	625.80	190.65	435.15	228.25
15 tons/ha	13.95	837.00	214.15	622.85	290.85
20 tons/ha	14.87	892.20	232.58	659.62	283.61
25tons/ha	30.48	1828.8	261.49	1567.31	599.38

Price used in the computation of gross income was Php 60/kg.

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The study was conducted at the organic demonstration farm from November 18, 2011 to March 10, 2012 using Randomized Complete Block Design (RCBD). Different rates of vermicompost application was used in the study. The study was conducted to: 1) Determine the best rate of vermicompost on the growth of cabbage under protected environment; 2) Determine the best rate of vermicompost on the yield of cabbage (var. Scorpio); 3) Determine the effect of vermicompost on some physical and chemical properties of the soil; and, 4) Determine the economic benefit of using cabbage production under controlled environment.

On the Agronomic parameters the dry matter yield (DMY), solidity, and yield of cabbage (var. Scorpio) affected by vermicompost. Application of 20 and 25 tons ha^{-1} vermicompost significantly produced the highest dry matter yield. However, high total yield was registered from those applied with 25 tons ha^{-1} . On the solidity, application of 15, 20 and 25 tons ha^{-1} enhanced hardest head among the treatments.

The different rates of vemicompost application significantly increased the water holding capacity, the bulk density, and porosity of the soil. Increasing the amount of vermicompost from 10 – 25 tons ha^{-1} decreased the Db indicating that the soil is porous and friable.

On the other hand, the result showed that the soil pH had decreased over the initial. While the OM and the N showed an increased over the initial. As the rate of vermicompost increased the OM and the N content of the soil also increased.

The return on cash expense (ROCE) obtained positive in all treatments (0, 10, 15, 20 ,and 25 tons ha^{-1}). But treatment 5 (25 tons ha^{-1}) gave the highest return of 599.38 %.

Conclusions

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

1) Vermicompost applied at 15-25 tons ha^{-1} produced the hardest cabbage heads.

2) Application of 20 to 25 tons ha^{-1} vermicompost gave the highest dry matter yield (DMY); and

3) The yield of cabbage and return of cash expense were highest in plots applied with 25 tons ha^{-1} vermicompost.

Recommendations

The following recommendations were formulated based on the results and conclusions:

1) Application of 25 tons ha^{-1}vermicompost can be recommended in the production of cabbage (var. Scorpio); and

2) A follow – up study is recommended to verify the results.

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