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ABSTRACT

The study on the organic fertilizer application for the optimum production of potato var. Raniag was conducted at the Benguet State University Organic Demo Farm, La Trinidad, Benguet from January 2011 to March 2011 to: determine the effect of the organic fertilizers on the physical and chemical properties of the soil; to determine the effect of organic fertilizers on the yield of potato tubers and to determine the best combination of different organic fertilizers to produce optimum yield of potato tubers.

Application of any organic materials to the soil either separately or in combination with others improves the physical and chemical properties such as bulk density, organic matter, nitrogen and phosphorus content of the soil.

Applications of pure chicken manure enhance the marketable and non-marketable yield of potato. Moreover, the weights of classified tubers were significantly influenced by the application of different organic fertilizers.

Applications of fresh wild sunflower directly to the soil significantly increase the pH of the soil.

Application of 5 tons/ha growers compost plus 5 tons/ha fresh wild sunflower is the best combination for optimum yield of potato. Moreover, application of chicken manure significantly enhanced yield of potato.

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INTRODUCTION

Potato (*Solanumtuberosum*) is classified as a cool season cropgrown especiallyin Benguet and Mt. Province because of its favorable climatic conditions. Potato production is one of the principal sources of income of the Filipino farmers speciallyin Benguet and Mt. Porvince. People in many countries make potato as one of the major foods in their diet because it provides energy, vitamins, minerals and amino acids. It is also an essential ingredientof snack foodssuch as mashed potato, potato chips, potato flour, and an excellent mixture for pork adobo. Aside from being eaten as food it is also used as an industrial source of starch and other derivatives.

Organic fertilizer is very rich in nutrients such as the macronutrients that are needed in the healthy growth of plants.Likewise, it improves the physical and chemical properties of the soil. On the other hand, inorganic fertilizers are also rich in nutrients needed by the plants. However, in terms of the repetitive application,it will destroy the physical and chemical properties of the soil. Organic fertilizer is the best alternative because it improves the soil structure, soil tilth, water holding capacity, aeration and it can also reduce inputs of the farmers.

Due to continuous cropping, crop and grass removal to the farm, it is simply noticed that nutrient depletion of the soil is very fast. To avoid depletion of the soil, farmers need to convert to using organic material instead of using the commercial fertilizersto return back the natural condition of the soil and also to promote good condition of the soil.

The findings of this study can provide information on the best organic fertilizer application that could be introduced to improve soil fertility and to minimize high cost of potato production.

The study aimed to:

1) Determine the effect of different organic fertilizers on physical and chemical properties of the soil.

2) Determine the effect of organic fertilizers on the yield of potato tubers; and,

3)Determine the best combination of organic fertilizers to produce optimum yield of potato.

The study was conducted at the Organic Demo Farm,Benguet State University, La Trinidad, Benguetfrom January 2011 to March 2011.

REVIEW OF LITERATURE

Effect of Organic Fertilizer on Crop

Organic fertilizers have great and favorable effects to crops. Plant resistance to pest and diseases are increased when fertilized with organic matter. Little or no soil borne disease will occur in the soil that is high in organic matter because of oxygen ethylene cycle in the soil (Abadilla, 1982).

Adchak (1993)found out that application of 60 kg N/ha in combination with 15 tons chopped wild sunflower improved the growth and yield of cabbage. Likewise, it improved the physical and chemical properties of the soil.

Pandosen (1986) stated thatplants treated with either composted or fresh wild sunflower or chicken manure gave higher yield than the plants treated with inorganic fertilizers and those with inoculation. This result could be due to the higher values obtained from organic fertilizers.

Boltican (2008) reported that different mixture of organic fertilizer significantly affected the height of potato plants and the weight of extra large potato tubers. Application of 6 tons/ha chicken manure, 6 tons/ha fresh sunflower enhance better height and total yield of potato per plot.

Organic matter level in the soil could be maintained by the liberal use or application of green farm and green manure to the soil. Organic fertilizers supply some amount of the nutrient requirements of the crop and they promote favorable soil properties, such as granulation and good tilth for efficient aeration, easy root penetration and improved water holding capacity (PCARRD, 1982). Organic fertilizers are generally used on vegetable crops, root crops and ornamentals in combination with inorganic

fertilizers. Organic fertilizers are as effective as chemical fertilizers in increasing crop yields. They make the soil rich since they contain a substantial amount of nutrients. Plants nourished with organic fertilizers are healthier and more resistant to pest and diseases (PCARRD, 1983).

Donahue (1971) also stated that organic matter supplies nutrients needed by the growing plants as well as hormones and antibiotics. These nutrients are released in harmony with the needs of plants when the environmental condition favors a rapid release of nutrients for the organic matter. Organic matter contains a large part of the total reserve of boron, molybdenum, 5-6% phosphorous up to 80% sulfur and particularly most of nitrogen.

Farm manure has high nitrogen content and has good influence on the soil and it is available to crops (Toledo, 1982). Besides, Brady (1990) reported that plants fertilized with chicken dung matured earlier and were taller than the plants fertilized with sawdust, cow manure and also with pig manure.

Koshino (1990), pointed out that during the decomposition of organic matter, nutrient elements are slowly released which is particularly important in avoiding salt injury, ensuring a continuous supply of nutrients throughout the growing season. Likewise, it is important in producing better quality of crops.

Effect of Organic Fertilizers on Physical Properties of the soil.

Brady and Weil (2000) claimed that organic matter binds mineral particles into granular soil structure that is largely responsible for the loose, easily managed condition of productive soil. It also increases the amount of water a soil can hold and the proportion of water available for the plant growth.

Chapman (1976) mentioned that organic matter includes green manure and animal manure which provide not only an important effect on the soil but also provide both macro and microelements as source of nutrition to plants. One of the effect is the loosening of the soil, enhances good soil structure thereby increasing the water holding capacity and infiltration rate of the soil.

Lacay (2008) said that vermicompost have a very high water holding capacity.It has a good structure which makes it desirable component of potting mixes.

Effect of Organic Matter on Chemical Properties of the Soil

Brady and Weil (2002) reported that organic matter is a source of the plant nutrients. It also provides much of the cation exchange and water holding capacities of surface soil. Furthermore, organic matter supplies energy and body building constituents for most of the microorganisms.

Chicken manure

De la Cruz (2004) stated that crops applied with animal manure performed better compared to those crops that were grown with commercial organic fertilizers. The slow release of nutrient from animal manure minimized the nutrient losses in the soil resulting to the efficient uptake to crops that lead in higher yield. Animal manure also serves as a valuable conditioner of the soil retaining humidity and improving structure and internal drainage.

Importance of vermicompost

Singh (2001) stated that vermicompost has a pH of 7 to 7.5 and a C: N ratio of 12 to 15: 1. Through chemical analysis, it contains 1.75 to 2.5% N, about 1.25 to 2% K, calcium, magnesium, sulfate which is 3-5% times better than farm manure.

Wild sunflower.

Wild sunflower has been known to be a good source of organic nitrogen besides being free; it is readily available on the farmyards. Sunflower as organic fertilizer insures vigorous growth of plants and influences nutrient absorption due to its role in granulation thereby improving the physical and chemical properties of the soil (Brady, 1974) as cited by Durante (1982).

Victor (1974) as cited by Bernard (2009) stated that wild sunflower which is abundant in the highlands can be a substitute organic nitrogen source and as a starter of compost for it hastens further decomposition. Through laboratory analysis, Pandosen (1986) found that fresh wild sunflower contains 3.76% nitrogen and wild sunflower based compost contains 3.22% nitrogen.

MATERIALS AND METHODS

The materials used in the experiment were the following: chicken manure, grower's compost, vermicompost, fresh wild sunflower and potato seed tubers varietyRaniag.

An area of 120 m^2 was divided into three blocks with each block containing eight individual plots measuring 1m x 5m. Each plot represents a treatment and was laid out in a simple RCBD with three replications.

The different treatments are as follows:

T_1= control

T_2= 10 tons/ha dry chicken manure

T_3= 10 tons/ha vermicompost

T_4= 10 tons/ha growers compost

T_5= 10 tons/ha fresh wild sunflower

T_6= 5 tons /ha chicken manure plus5 tons/ha FWS

T_7= 5 tons /ha vermicompost plus5 tons /ha FWS

T_8= 5 tons /ha growers compost plus5 tons /ha FWS

All the organic fertilizers were applied one week before planting following the differenttreatments. The fresh wild sunflower was chopped into small pieces prior to application. Potato tubers were planted at a distance of 20 cm x 30 cm between hills and rows in order to have equal number of hills per plot. Hilling up was done two weeks after planting.All other cultural practices such as irrigation and disease control were done including removal of the weeds if there is an occurrence to prevent competition.

The data gathered were the following:

A. Chemical Properties of the Soil

1. Soil pH. Theinitial and final pH was determinedusing 1:1 soil and water suspension.

2. Organic matter content of the soil (%). This was analyzed using theWalkley-Black method.

3.Totalnitrogen content (%). The total nitrogen content of the soil was computed by multiplying the factor 0.05 to the % OM content of the soil.

4.Available Phosphorus content (ppm). This was determined using the Bray No. twomethod.

B. Physical Properties of the Soil

1. Bulk density (g/cm^3). This was obtained using the core method. The working formula used to compute the bulk density was:

$$Db = \frac{\text{Oven dry weight of soil (g)}}{\text{Volume of the soil } (cm^3)}$$

C. Agronomic parameters

1.Marketable yield. The classifications were basedon the weight as follows:

a) Large(kg) = tubers weighing 80-99g

b) Medium (kg) = tubers weighing 50-79g

c) Small (kg) = tubers weighing <50g

d) Total weight of marketable tubers (kg)

e) Total weight of non-marketable tubers (kg)

2. Total yield of marketable and non-marketable tubers (kg)

D. Economic Analysis

1. Return on Cash Expenses (%). The return on cash expenses was computed per plotusing the formula:

ROCE (%) = Gross Income – Total Expenses x 100
Total Expenses

RESULTS AND DISCUSSION

Some Chemical Properties of the Soil

Soil pH.The initial soil pH of 5.12 was significantly increased by the different organic fertilizers applied as presented in Table 1. As individually applied 10 tons/ha fresh wild sunflower (T_5) effected the highest soil pH with a mean of 5.91 which significantly differed from the other treatments when combined, however, with the other organic fertilizers the pH decreased.

Table 1. Soil pH as affected by different organic fertilizers

TREATMENT	pH
Control	5.48[e]
10 tons/ha dry chicken manure	5.55[d]
10 tons/ha vermicompost	5.78[c]
10 tons/ha growers compost	5.78[c]
10 tons/ha fresh wild sunflower	5.91[a]
5 tons /ha chicken manure + 5 tons/ha FWS	5.18[f]
5 tons /ha vermicompost + 5 tons /ha FWS	5.84[bc]
5 tons /ha growers compost + 5 tons /ha FWS	5.87[ab]
Initial	5.12

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

The result shows that fresh wild sunflower and growers compost have greater capacity to increase soil pH. This could be due to the calcium (1.90 %) content and magnesium (0.39 %) content of fresh wild sunflower aside from its high amount of NPK content Pandosen (1986).

She further confirmed that application of organic fertilizers like chicken manure, fresh wild sunflower, and based-compost increased the pH of the soil which indicates that the use of organic fertilizer do not add to the acidity of the soil to a greater extent.

Organic matter content of the soil. Table 2 shows that the application of organic fertilizers significantly increased the organic matter content of the soil, however, the increase varies on the kind of material. Further, application of five tons/ha chicken manure plus five tons/ha fresh wild sunflower registered the highest organic matter content of the soil. The result could be attributed to the low pH as shown in Table 1. Acidity can slow down organic matter decomposition due to acid precipitation on the site has caused high acidity in the litter of the organic layer causing a reduction in decomposition. Wolters and Schaefer (1994).

As stated bCabading (2010) the application of different organic fertilizers improved the organic matter content of the soil by 5.49% to 6.098%.

On the other hand, application of 10 tons/ha fresh wild sunflower registered the lowest organic matter of 0.95% after harvest. The result implies that most of the nutrient contained in wild sunflower was utilized by potato.

Sun–ho-yoo and Yeong San Jung (1992) as cited by Lacay (2008) stated that organic matter is the principal reservoir of nitrogen and other nutrients.

Table 2. Organic matter content of the soil as affected by different organic fertilizers

TREATMENT	OM (%)
Control	0.94[c]
10 tons/ha dry chicken manure	1.63[abc]
10 tons/ha vermicompost	1.00[bc]
10 tons/ha growers compost	1.06[bc]
10 tons/ha fresh wild sunflower	0.95[c]
5 tons /ha chicken manure + 5 tons/ha FWS	2.05[a]
5 tons /ha vermicompost + 5 tons /ha FWS	1.76[ab]
5 tons /ha growers compost + 5 tons /ha FWS	1.31[abc]
Initial	0.93

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

It increase soil buffering capacity, helps maintain a good soil structure and protect soil from erosion and maintains a high community of soil microorganism.

Total nitrogen content of the soil. As presented in Table 3,the plots applied with the combination of chicken dung plus fresh wild sunflower registered the highest total nitrogen content of the soil with a mean of 0.10%. This is due to the high content of chicken manure especially in nitrogen and because of the wild sunflower combined. The result implies that combination of chicken manure and wild sunflower can store nitrogen in longer period of time as compared to other organic fertilizer combinations. Moreover, the combination of 5 tons/ha vermicompost plus 5 tons/ha fresh wild sunflower gave the

mean of 0.09% total nitrogen content of the soil. As observed, the control registered the lowest total nitrogen with a mean of 0.05 % implying that whatever nitrogen present in the soil was utilized. Statistically, the differences between the treatments are significant.

Brady and Weil (2008) cited that soil organic matter contains large quantities of plant nutrients and act as a slow-release nutrient storehouse, especially for nitrogen. Sunflower also increases the nutrient content of compost. Through laboratory analysis, Pandosen (1986) found that fresh wild sunflower contains 3.76 % nitrogen and wild sunflower based compost contains 3.22 % nitrogen. It is therefore a good source of organic nitrogen.

Table 3.Total nitrogen content of the soil as affected by different organic fertilizers

TREATMENT	NITROGEN (%)
Control	0.05[c]
10 tons/ha dry chicken manure	0.08[abc]
10 tons/ha vermiccompost	0.05[c]
10 tons/ha growers compost	0.05[bc]
10 tons/ha fresh wild sunflower	0.05[c]
5 tons /ha chicken manure + 5 tons/ha FWS	0.10[a]
5 tons /ha vermicompost + 5 tons /ha FWS	0.09[ab]
5 tons /ha growers compost + 5 tons /ha FWS	0.06[bc]
Initial	0.050

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

Available phosphorus content of the soil. Table 4 reveals that soils applied with 10 tons/ha chicken manure registered the highest available phosphorus content of the soil.The result indicates that application of chicken manure somewhat deters the phosphorus absorption by plants maybe due to the acidy although application of different organic fertilizers highly influenced the available phosphorous content of the soil. Soils not applied with organic fertilizer gave the lowest available phosphorus content of the soil with a mean of 18.03 ppm.The increase in the phosphorus content can be attributed to the role of organic material which is a residue of dead and dying plant materials is a reservoir of nitrogen, phosphorus, sulfur and other macronutrient elements essential for plant growth (Jones, 1982).

Table 4. Available phosphorus content of the soil as affected by organic fertilizers

TREATMENT	PHOPHORUS (ppm)
Control	18.03[c]
10 tons/ha dry chicken manure	30.92[a]
10 tons/ha vermicompost	24.42[b]
10 tons/ha growers compost	29.90[a]
10 tons/ha fresh wild sunflower	23.34[b]
5 tons /ha chicken manure (T_2) + 5 tons/ha FWS (T_5)	26.99[ab]
5 tons /ha vermicompost (T_3) + 5 tons /ha FWS (T_5)	27.06[ab]
5 tons /ha growers compost (T_4) + 5 tons /ha FWS (T_5)	27.27[ab]
Initial	19.33

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

The findings conform the finding of Cox and Jackson (1960) that the increase in soil phosphorus was due to the organic materials applied which contains appreciable amount of organic phosphates which are present as complex organic phosphorus esters.

Some Physical Properties of the Soil

Bulk density of the soil. Table 5 shows the bulk density of soil as affected by the different organic fertilizer applications. It is observed that bulk density of the soil was improved from an initial value of 1.25 g/cm^3.

The lowest bulk density was observed in the plots applied with fresh wild sunflower with a mean of 1.04 g/cm^3. The control plots registered the highest bulk density with a mean of 1.27 g/cm^3. Result shows the relevance of applying organic to soils. This is because organic matter encourages granulation, and makes the soil porous, which result in low bulk density values (Brady, 1990).

Among the organic materials applied, application of fresh wild sunflower gave the lowest bulk density of 1.04 g/cm^3 which is significantly lower compared to the other organic materials. This confirms with the report of Pandosen (1986) that a decrease in bulk density of the soil is realized when it is applied with fresh wild sunflower and sunflower-based compost. This indicates that the application of sunflower either as solid or in liquid fertilizer form improves the bulk density of the soil.

This is in consonance with the findings of Hausenbuiller (1978) that organic matter tends to lower bulk density, either by encouraging higher porosity through soil aggregation or by reducing the average density of the soil. This characteristic signifies that more organic matter will hold more water at a longer duration.

Table 5. Bulk density of the soil as affected by different organic fertilizers

TREATMENT	BULK DENSITY ($g/cm^{3)}$
Control	1.27^{d}
10 tons/ha dry chicken manure	1.17^{c}
10 tons/ha vermicompost	1.10^{bc}
10 tons/ha growers compost	1.08^{bc}
10 tons/ha fresh wild sunflower	1.04^{a}
5 tons /ha chicken manure + 5 tons/ha FWS	1.09^{bc}
5 tons /ha vermicompost + 5 tons /ha FWS	1.07^{b}
5 tons /ha growers compost + 5 tons /ha FWS	1.07^{b}
Initial	1.25

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

Agronomic Parameters

Weight of classified potato tubers. Table 6 shows the weight of classified small, medium and large potato tubers. As separate organic fertilized for potato, it is observed that the fertilizer that produced the heaviest large tubers, the weight of medium and small also followed. The rank from highest to lowest is with the use of chicken manure, growers compost, vermicompost and wild sunflower respectively.

Combining fresh wild sunflower with the other materials improved the weight of large, medium but decrease the weight of small tubers. This is realized on plants fertilized with fresh wild sunflower combined with chicken manure.

Table 6.Weight of classified potato tubers as affected by different organic fertilizer

TREATMENT	MEAN (kg/5m^2)		
	LARGE	MEDIUM	SMALL
Control	2.13^{d}	2.73^{c}	1.15^{e}
10 tons/ha dry chicken manure	4.38^{a}	6.12^{a}	1.92^{ab}
10 tons/ha vermicompost	3.63^{b}	5.68^{a}	1.58^{bcd}
10 tons/ha growers compost	3.73^{b}	5.85^{a}	1.72^{bc}
10 tons/ha fresh wild sunflower	2.92^{c}	4.77^{b}	1.43^{cde}
5 tons /ha chicken manure + 5 tons/ha FWS	4.52^{a}	5.60^{ab}	1.25^{de}
5 tons /ha vermicompost + 5 tons /ha FWS	4.07^{ab}	5.53^{ab}	2.15^{a}
5 tons /ha growers compost + 5 tons /ha FWS	4.08^{ab}	5.65^{ab}	1.85^{ab}

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

Statistical analysis showed that the difference between treatments was observed to be highly significant.

Boltican (2008) reported that different mixture of organic fertilizer significantly affected the height, weight and yield of potato tubers. Application of 6 tons/ha chicken manure, 6 tons/ha fresh sunflower enhance better height and total yield of potato per plot.

Marketableyield.

The weight of marketable yield of potato was significantly affected by the different organic fertilizers(Table 7). The highest marketable yield was obtained from plotsapplied with 10 tons/ha chicken manure with a mean of 12.42 kg/5m^{2}that

significantly differed from the plots treated with 10 tons/ha fresh wild sunflower and control plots with a mean of 9.12 and 6.02 kg/5m^{2}except for the plots treated with 10 tons/ha vermicompost, 10 tons/ha growers compost, 5 tons/ha chicken manure plus 5 tons/ha fresh wild sunflower, 5 tons/ha vermicompost plus 5 tons/ha fresh wild sunflower, 5 tons/ha growers compost plus 5 tons/ha fresh wild sunflower. This conforms to the study of Lipawen (2009) that the application of 5 tons/ha chicken manure produced the highest marketable yield of carrots kg/5m^2.This effect on yield was attributed to the manure that contains essential plant nutrients as well as some trace elements not generally found in chemical fertilizers (Jones, 1982). With this, application of 5 tons/ha chicken manure enhanced higher yield of carrots plants.

Non – marketable Yield

The weight of non-marketable yield of potato was significantly affected by different organic fertilizers is shown in Table 7. Soils applied with 10 tons/ha growers compost recorded the lowest non-marketable yield with a mean of 0.15 kg/5m^2. This could be attributed to the higher marketable yield and less infected of potato tubers.

Lower non-marketable yield was obtained from these treatments due to the higher marketable yield obtained. Higher non-marketable yield was obtained from plots applied with 10 tons/ha chicken manure due to higher marketable yield and high tubers produced.

Total Yield

Total yield of potato as affected by different organic fertilizers is shown in Table 7. Heaviest tuber was obtained from the plots applied with 10 tons/ha chicken manure with a mean of 13.05 kg/5m^2. The mean differed significantly from thecontrol and those

plots applied with 10 tons/ha fresh wild sunflower. This result conforms to the findings of Lingaling (2006) as cited by Cabading (2010) that carrots grown in plots applied with chicken manure matured earlier that resulted in the production of heavier carrots. This could be attributed to the other organic fertilizers. Growers compost also produced heavier yield due to the chicken manure and wild sunflower contained in it with higher nutrient content of 1.66 % N, 2.49 % P and 2.82 % K. The different organic fertilizers applied had greatly influenced the total yield of potato tubers.

Table 7. Marketable, non-marketable and total yield of potato tubers as affected by different organic fertilizers

TREATMENT	MEAN(kg/5 m^2)		
	MARKETABLE YIELD	NON MARKETABLE YIELD	TOTAL YIELD
Control	6.02^{d}	0.47^{bc}	6.48^{d}
10 tons/ha dry chicken manure	12.42^{a}	0.63^{a}	13.05^{a}
10 tons/ha vermicompost	10.90^{b}	0.37^{c}	11.27^{b}
10 tons/ha growers compost	11.30^{b}	0.15^{d}	11.45^{b}
10 tons/ha fresh wild sunflower	9.12^{c}	0.55^{ab}	9.67^{c}
5 tons /ha chicken dung + 5 tons/ha FWS	11.37^{b}	0.53^{ab}	11.90^{b}
5 tons /ha vermicompost+ 5 tons/ha FWS	11.75^{ab}	0.38^{c}	12.13^{ab}
5 tons /ha growerscompost+5tons/ha FWS	11.58^{ab}	0.38^{c}	11.97^{b}

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

As stated by Brady and Weil (2002) as soil organic matter decays, nutrient elements which are present in organic combination are released as soluble ions that can be taken up by plant roots.

Economic Analysis

Return on cash expenses.The highest return on cash expenses was realized from the application ofthe combination of 5 tons/ha growers compost plus 5 tons/ha fresh wild sunflowerwith a value of 145.80% due to high content of nutrient regardless with minimal inputs (Table 8).

Table 8. Return on cash expense

TREATMENT	TOTAL YIELD (kg)	GROSS INCOME	PRODUCTION COST	NET INCOME	ROCE (%)
Control	6.02	382.2	268.29	113.91	42.46
Chicken manure	12.42	793.62	343.29	450.33	131.18
Vermicompost	10.90	693.63	388.29	95.34	78.64
Growers compost	11.30	718.47	343.29	375.18	109.29
Fresh wild sunflower	9.12	578.13	280.79	297.34	105.89
Chicken manure plus wild sunflower	11.37	738.75	300.79	437.96	145.60
Vermicompost plus wild sunflower	11.75	746.7	353.29	393.41	111.4
Growers compost plus wild sunflower	11.58	739.35	300.79	438.56	145.80

Likewise, the application of 5 tons/ha chicken manure plus 5 tons/ha fresh wild sunflower ranked second with a value of 145.60%. Although vermicompost yielded high, it has a low ROCE of 78.64% and this is due to the higher cost of vermicompost. Likewise, the use of other fertilizers that gave high ROCE can be attributed to high yield and minimal fertilizer cost.

Cabading (2010) stated that the application of 5 tons/ha chicken manure increased a total production cost of PhP 420.93 and net income of 491.39 with the highest return on cash expenses.

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

The study on the organic fertilizer application for optimum production of potato var. Raniag using different organic fertilizers was conducted at the Benguet State University Organic Demo Farm, La Trinidad, Benguet from January 2011 to March 2011 to determine the organic fertilizers on the physical and chemical properties of the soil, to determine the effect of organic fertilizers on the growth and yield of potato tubers; and, to determine the best combination of different organic fertilizers to produce optimum yield of potato tubers.

Application of differentorganic fertilizers significantly reduced the bulk density of the soil due to granulation. The soil pH, organic matter, nitrogen, and available phosphorus content of the soil were improved with the application of organic fertilizer as compared to the control.

Plots treated with pure wild sunflower significantly increased thesoil pH, reduced total nitrogen, organic matter and available phosphorus in the soil. It can be deduced that the nutrient content of the wild sunflower has been utilized by potato. of the soil from an initial of 5.12 to 5.91.

Conversely, application of 10 tons/ha chicken manure plus 5 tons of wild sunflower gave the highest organic matter content of the soil due to acidity.

In terms of yield of potato tubers, soils applied with 5 tons/ha growers compost plus 5 tons/ha fresh wild sunflowersignificantly produced the highest marketable yield, total yield and highest Return on Cash Expense.

Conclusion

Based on the result of the study, application of the different organic fertilizers significantly affected the physical and chemical properties of the soil. It improved the bulk density, increased pH, organic matter, nitrogen and phosphorus content of the soil after harvest.Application of 5 tons/ha growers compost plus 5 tons/ha fresh wild sunflower is the best combination that gave the optimum yield of potato. Moreover, application of pure chicken manure significantly enhanced higher marketable and total yield of potatoes.

Recommendation

Based from the result and findings of the study, it is recommended that a follow-up study should be done to further investigate the effect of organic fertilizer application for the optimum production of potato var. Raniagusing thedifferent organic fertilizers.

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APPENDICES

Appendix Table 1.Soil pH

REPLICATION / TREATMENT	I	II	III	TOTAL	MEAN
T_1	5.50	5.46	5.48	16.44	5.48
T_2	5.55	5.57	5.54	16.66	5.55
T_3	5.79	5.79	5.77	17.35	5.78
T_4	5.85	5.72	5.78	17.35	5.78
T_5	5.96	5.85	5.92	17.73	5.91
T_6	5.21	5.18	5.16	15.55	5.18
T_7	5.86	5.81	5.84	17.51	5.84
T_8	5.85	5.87	5.89	17.61	5.87
TOTAL	45.57	45.25	45.38	136.20	5.68

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	0.0065	0.0032			
Treatment	7	1.3123	0.1875	200.99**	2.77	4.28
Error	14	0.0131	0.0009			
TOTAL	23	1.3318				

** = highly significant CV= 0.54%

Appendix Table 2.Organic matter content of the soil (%)

REPLICATIONS TREATMENT	I	II	III	TOTAL	MEAN
T_1	0.96	0.90	0.96	2.82	0.94
T_2	1.19	1.86	1.84	4.89	1.63
T_3	1.03	1.23	0.85	3.11	1.04
T_4	0.78	1.25	1.16	3.19	1.06
T_5	0.90	0.96	0.99	2.85	0.95
T_6	1.30	2.76	2.08	6.14	2.05
T_7	2.33	1.10	1.86	5.29	1.76
T_8	1.48	1.08	1.39	3.95	1.32
TOTAL	9.97	10.06	11.13	32.24	1.34

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	0.1035	0.5177			
Treatment	7	3.8004	0.5229	3.33**	2.77	4.28
Error	14	2.2827	0.1630			
TOTAL	23	6.187				

**= highly significant CV= 30.16%

Appendix Table 3.Total nitrogen content of the soil (%)

REPLICATION / TREATMENT	I	II	III	TOTAL	MEAN
T_1	0.05	0.05	0.05	0.15	0.05
T_2	0.06	0.09	0.06	0.24	0.08
T_3	0.05	0.06	0.05	0.15	0.05
T_4	0.04	0.06	0.04	0.16	0.05
T_5	0.05	0.05	0.05	0.15	0.09
T_6	0.07	0.14	0.07	0.31	0.10
T_7	0.12	0.06	0.12	0.27	0.09
T_8	0.07	0.05	0.07	0.19	0.06
TOTAL	0.46	0.56	0.55	1.57	0.07

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	0.00017	0.00008			
Treatment	7	0.00925	0.00123	3.41*	2.77	4.28
Error	14	0.00542	0.00038			
TOTAL	23	0.01484				

*= significant

CV= 29.16%

Appendix Table 4.Available phosphorus content of the soil (ppm)

REPLICATION / TREATMENT	I	II	III	TOTAL	MEAN
T_1	18.15	20.41	15.54	54.10	18.03
T_2	31.19	31.58	29.98	92.75	30.92
T_3	27.52	25.86	19.88	86.93	28.98
T_4	27.69	28.47	33.55	89.71	29.90
T_5	25.81	24.75	19.46	70.02	23.34
T_6	26.47	27.97	26.52	80.96	26.99
T_7	28.31	24.96	27.91	80.59	26.86
T_8	28.30	27.37	26.15	81.82	27.27
TOTAL	213.44	211.37	286.11	636.88	26.54

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	15.2647	7.6323			
Treatment	7	348.5020	49.7860	8.28**	2.77	4.28
Error	14	84.1683	6.0120			
TOTAL	23	447.93				

** = highly significant CV= 9.43%

Appendix Table 5.Bulk density of soil (g/cm^3)

REPLICATION / TREATMENT	I	II	III	TOTAL	MEAN
T_1	1.27	1.25	1.29	3.81	1.27
T_2	1.18	1.15	1.17	3.50	1.17
T_3	1.10	1.08	1.11	3.29	1.10
T_4	1.12	1.07	1.06	3.25	1.08
T_5	1.04	1.02	1.05	3.11	1.04
T_6	1.09	1.08	1.11	3.28	1.09
T_7	1.06	1.05	1.09	3.20	1.07
T_8	1.04	1.08	1.10	3.22	1.07
TOTAL	8.9	8.78	8.98	26.66	1.11

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	0.0025	0.0013			
Treatment	7	1.1157	0.0165	46.91**	2.77	4.28
Error	14	0.00493	0.0004			
TOTAL	23	0.12317				

**= highly significant CV= 1.69%

Appendix Table 6.Weight of large size tubers (kg/5m^2)

REPLICATION / TREATMENT	I	II	III	TOTAL	MEAN
T_1	2.15	1.90	2.35	6.40	2.13
T_2	3.70	4.90	4.55	13.15	4.38
T_3	4.15	3.45	3.30	10.90	3.63
T_4	3.95	3.75	3.50	11.20	3.73
T_5	3.10	2.90	2.75	8.75	2.92
T_6	4.75	4.30	4.50	13.55	4.52
T_7	4.15	3.80	4.25	12.20	4.07
T_8	3.95	4.10	4.20	12.25	4.08
TOTAL	29.9	29.1	29.4	88.4	3.68

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	0.0408	0.0204			
Treatment	7	13.4600	1.9229	16.39**	2.77	4.28
Error	14	1.6425	0.1173			
TOTAL	23	13.5008				

**= highly significant CV = 9.30%

Appendix Table 7.Weight of medium size tubers (kg/5m^2)

REPLICATION / TREATMENT	I	II	III	TOTAL	MEAN
T_1	3.10	2.20	2.90	8.20	2.73
T_2	6.30	5.95	6.10	18.35	6.12
T_3	5.55	5.80	5.70	17.45	5.82
T_4	5.70	5.35	6.50	17.55	5.85
T_5	4.20	4.35	5.75	14.30	4.77
T_6	5.90	4.75	6.15	16.80	5.60
T_7	5.60	5.90	5.10	16.60	5.53
T_8	5.70	5.50	5.75	16.95	5.65
TOTAL	42.05	39.8	38.2	126.2	5.26

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	1.0789	0.53947			
Treatment	7	24.6850	3.52642	15.95**	2.77	4.28
Error	14	3.0943	0.22102			
TOTAL	23	28.86				

**= highly significant CV = 8.97%

Appendix Table 8.Weight of small size tubers (kg/5m^2)

REPLICATION / TREATMENT	I	II	III	TOTAL	MEAN
T_1	1.15	1.10	1.20	2.45	1.15
T_2	1.90	1.75	2.10	5.75	1.92
T_3	1.70	1.60	1.45	4.75	1.58
T_4	2.10	1.40	1.65	5.15	1.72
T_5	1.85	1.25	1.20	4.30	1.43
T_6	1.30	1.30	1.15	3.75	1.25
T_7	2.20	2.30	1.95	6.45	2.15
T_8	1.95	1.85	1.75	5.55	1.85
TOTAL	14.15	12.55	12.45	32.7	1.63

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	0.2275	0.1136			
Treatment	7	2.4724	0.3532	10.21**	2.77	4.28
Error	14	0.4842	0.4842			
TOTAL	23					

**= highly significant CV = 4.91%

Appendix Table 9.Weight of marketable tubers (kg/5m^2)

REPLICATION / TREATMENT	I	II	III	TOTAL	MEAN
T_1	6.40	5.20	6.45	18.05	6.02
T_2	11.90	12.60	12.75	37.25	12.42
T_3	11.40	10.85	10.45	32.70	10.90
T_4	11.75	10.50	11.65	33.90	11.30
T_5	9.15	8.50	9.70	27.35	9.12
T_6	11.95	10.35	11.80	34.10	11.37
T_7	11.95	12.00	11.30	35.25	11.15
T_8	11.60	11.45	11.70	34.75	11.58
TOTAL	86.10	81.45	85.50	253.35	10.56

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	1.6931	0.8465			
Treatment	7	89.8482	12.835	47.79**	2.77	4.28
Error	14	3.7602	0.2686			
TOTAL	23	95.30				

** = highly significantCV = 4.91%

Appendix Table 10.Weight of non- marketable tubers (kg/5m^2)

REPLICATION / TREATMENT	I	II	III	TOTAL	MEAN
T_1	0.40	0.50	0.50	1.40	0.13
T_2	0.60	0.70	0.60	1.90	0.63
T_3	0.50	0.35	0.25	1.10	0.37
T_4	0.20	0.15	0.10	0.45	0.15
T_5	0.65	0.55	0.45	1.65	0.55
T_6	0.60	0.55	0.45	1.60	0.53
T_7	0.45	0.35	0.35	1.15	0.38
T_8	0.40	0.30	0.45	1.15	0.38
TOTAL	3.80	3.45	3.15	10.40	0.43

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	0.0265	0.0132			
Treatment	7	0.4633	0.0662	12.60**	2.77	4.28
Error	14	0.0735	0.0053			
TOTAL	23					

** = highly significant CV = 16.73%

Appendix Table 11.Total yield of potato tubers (kg/5m^2)

REPLICATION / TREATMENT	I	II	III	TOTAL	MEAN
T_1	6.80	5.70	6.95	19.45	6.48
T_2	12.50	13.30	13.35	39.15	13.05
T_3	11.90	11.20	10.70	33.80	11.27
T_4	11.95	10.65	11.75	34.35	11.45
T_5	9.80	9.05	10.15	29.00	9.67
T_6	12.55	10.90	12.25	35.70	11.90
T_7	12.40	12.35	11.65	36.40	12.13
T_8	12.00	11.75	12.15	35.90	11.97
TOTAL	89.90	84.90	88.95	263.75	10.99

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DEGREES OF FREEDOM	SUM OF SQUARES	MEAN OF SQUARES	COMPUTED F	TABULATED F 0.05	TABULATED F 0.01
Block	2	1.7627	0.2815			
Treatment	7	89.0466	12.7209	45.19**	2.77	4.28
Error	14	3.9406	0.2815			
TOTAL	23	94.75				

** = highly significant CV = 4.83%

Appendix Table 12.Return On Cash Expenses

	TREATMENT (PhP)							
PARTICULAR	T1	T2	T3	T4	T5	T6	T7	T8
Production cost:								
Potato tubers	20	20	20	20	20	20	20	20
Fertilizers:								
Chicken dung	0	75	0	0	0	37.5	0	0
Vermicompost	0	0	120	0	0	0	60	0
Growerscompost	0	0	0	75	0	0	0	37.5
Wild sunflower	0	0	0	0	12.5	12.5	12.5	12.5
Grub hoe	3.12	3.12	3.12	3.12	3.12	3.12	3.12	3.12
Labor:								
Tractor	22.5	22.5	22.5	22.5	22.5	22.5	22.5	22.5
Land preparation	14.06	14.06	14.06	14.06	14.06	14.06	14.06	14.06
Fertilizer - application	14.06	14.06	14.06	14.06	14.06	14.06	14.06	14.06
Planting	18.75	18.75	18.75	18.75	18.75	18.75	18.75	18.75
Watering	35.17	35.17	35.17	35.17	35.17	35.17	35.17	35.17
Hilling – up	23.44	23.44	23.44	23.44	23.44	23.44	23.44	23.44
Weeding	4.69	4.69	4.69	4.69	4.69	4.69	4.69	4.69
Harvesting	112.5	112.5	112.5	112.5	112.5	112.5	112.5	112.5
TOTAL EXPENSES	268.29	343.29	388.29	343.29	280.79	318.29	353.29	318.29
Gross income:								
Small (17.00/kg)	58.65	97.92	80.58	87.72	279.75	63.75	109.65	94.35
Medium (20.00/kg)	163.80	367.2	340.8	351	286.2	336	331.8	339
Large (25.00/kg)	159.75	328.5	272.25	279.75	219	339	305.25	306
TOTALINCOME	382.27	793.62	693.63	718.47	578.13	738.75	746.7	739.35
Net income	113.91	450.33	95.34	375.18	297.34	420.46	393.41	421.06
ROCE%	42.46	131.18	78.64	109.29	105.89	132.09	111.4	132.29
Rank	8	3	7	5	6	2	4	1

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