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Growth and yield performance of lettuce (*Lactuca sativa* L.) applied with different concentrations of fermented goat manure as Bio-fertilizer

Jayrome S. Butay*

Cagayan State University- Gonzaga Campus, Gonzaga, Cagayan, Philippines

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Abstract

The study was conducted to determine growth and yield performance of lettuce Lactuca sativa l with different concentrations of fermented goat manure as bio-fertilizer and aimed to find out which among the treatments can give the best result in terms of the average plant height in centimeters, average number of leaves in centimeter, average leaf area in centimeter, and fresh weight of plant in grams, seeds yield in grams and cost and return analysis. The study was conducted from January 17, 2018 to May 05, 2018 in single factor experiment in a Completely Randomized Design (CRD) replicated three times with four treatments. T1- Control, T2- 30ml of fermented goat manure per liter of water, and T3- 40ml of fermented goat manure per liter of water and T4- 50ml of fermented goat manure per liter of water. Application of fermented goat manure affected the growth and development of lettuce as manifested by the average plant height, the average number of leaves, average leaf area and fresh weight at harvest. Higher concentration (40–50ml per liter of water) proved to more efficient as indicated by the highest yield and ROI of 148.59 percent. The seed yield did not show a significant difference to each other. The study revealed that 50ml of fermented goat manure improved lettuce production further study is recommended to validate the result and come up with a more reliable conclusion.

***Corresponding Author:** Jayrome S. Butay ✉ gilbertmagulod_rdecsulasam28@yahoo.com

Introduction

Crop success depends on nutrient input during growth. The excessive use of chemical products in agriculture is an issue of concern for the various problems it causes, such as the level of pollutants that the fruit may contain, decrease in soil fertility, soil and groundwater pollution through the excessive use of N fertilizers, and animal waste causing an increase in nitrate concentration. (Hernandez *et al*, 2010). Likewise, the biodiversity having the fundamental value of human survival is being assaulted due to rapid and accelerating anthropogenic activities causing the persistent decline in species diversity (Magulod, 2018).

Lettuce (*Lactuca sativa* L.) is considered as the most popular salad vegetable which is usually grown and harvested within 30 to 45 days. Most people want to eat lettuce because it's fiber and nutritious content which makes it an ideal vegetable. Most farmers are interested to raise lettuce because of the price and high demand in the market. Through the years, farmers have optimizing yield using inorganic fertilizers. Typically, the essential nutrient from fertilizer inputs form part of the optimum production of crops but also contribute to the significant portion of total crop inputs cost leading many farmers having a dilemma of financing the agricultural inputs and the effect of overusing of inorganic pesticide to human health.

Researches showed that dependency on inorganic fertilizer to nourish agricultural land also resulted in soil pollution and imbalances. Due to the excessive application of inorganic fertilizers, the pH value of soil has shown a significant change. This has made most agricultural lands become stressed and unproductive. Because of the major disadvantage of inorganic fertilizers, several types of research have focused on managing fertilization need through gradually shifting into Good Agricultural Practices (GAP) to organic farming to reduce long-term input costs and bring back the fertility of the soil.

Goat manure was also found out to contain more nitrogen, phosphorus, and potassium (N, P, and K) than any other animal manure, such as those of cows, deer, horses, pigs, and chicken. Hence, it is a Bio-fertilizer is considered as a vital solution in revitalizing the fertility of the soil and bringing backs its humus and productivity. The study is therefore designed to generate scientific information that is lettuce production by using the different concentration of goat manure as a bio-fertilizer. To improve the production of crops by using organic bio-fertilizers, some efforts are required to fulfill a part of nutrients and improve the physical, chemical, and biological traits of the soil through the application of bio-organic fertilizers. Furthermore, various limitations of using organic fertilizers have been pointed out, such as the difficult access to trustworthy sources of information and the lack of specific research (Giulietti *et al*., 2008).

The objective of this study is to evaluate the effect of different concentrations of fermented goat manure as bio-fertilizer on lettuce. Specifically, it was conducted to 1.) Evaluate the growth and yield of lettuce with the addition of different concentrations of fermented goat manure as bio-fertilizer combined with the recommended rate of fertilizer; 2.) Identify the optimum combination of different concentrations of fermented goat manure as bio-fertilizer supplemented to the recommended rate of fertilizer effective for lettuce production; 3.) Evaluate which of the combination of different concentrations of fermented goat manure as a biofertilizer supplemented with the recommended rate of fertilizer has the highest return on investment.

Materials and methods

Research Design

The study is an experimental research which was conducted in a single factor experiment in Completely Randomized Design (CRD) with 4 treatments and 3 replications.

Laying-out the Experimental Area and Experimental Design

A total land area of 90. $75m^{-2}$ (5.5m x 16.5m) including alleys were used for the experiment. It was divided into three (3) blocks and each block was

further subdivided into 4 plots with a total of nine (12) plots. Each plot measures 1.5m x 3.5m with a total area of 10.5m² per plot.

Experimental Treatments

The experimental treatments used were the following: T1-Control**;** T2- 30ml of liquid goat manure per liter of water, T3- 40ml of liquid goat manure per liter of water, T4- 50ml of liquid goat manure per liter of water.

Gathering Procedure

Before land preparation, soil samples were collected in different locations within the experimental area at a depth and width of 6 inches. These soil samples were submitted to Cagayan Valley Integrated Agricultural Laboratory (CVIAL), Tuguegarao City for soil chemical and physical analysis.

Construction of Greenhouse

The greenhouse was made out of bamboo and net with a height of 7 ft. A total area of 90.5 square meters was covered and was used as the experimental area.

Land Preparation

The experimental area was thoroughly prepared to have a uniform seedling emergence and good root emergence. The area was prepared by plowing two times and harrowing one week after plowing. Pick Mattock and grab hoe was used to cultivate the area to break the soil clods for effective weed control after the second plowing and are ready for transplanting.

Application of Lime

The actual pH of the field was 4.54 which was not compatible with the pH requirement of lettuce that is 6 to 6.5. Hence, according to the soil analysis, it should be applied with lime with a total of 2 tons per hectare. Therefore 18.15kg was incorporated into the soil by plowing. Lime was applied one month before transplanting.

Seedlings Management

Seedlings were raised on seedling tray consisting of one part compost, one part carbonized rice hull (CRH), and one part garden soil with 3-5mm depth. And was sprinkled with water daily until the seedlings have emerged. Once the seedling appears, the watering routine may be lessened.

Transplanting

Transplanting was done two to three weeks after sowing or when they reach the height of 5cm to 8cm, and it was ensured that some soil is still attached to the roots. It was transplanted with a spacing of 25x30cm. Immediately water the seedling after transplanting. Water the seedlings daily. In cases of mortality, plants were re-planted 5-7 days after transplanting.

Fertilizer Application

According to soil analysis, the area needed 1.13kg of 16-20-0 and 1.76kg of 0-18-0, but due to unavailability of super Phosphate (0-18-0). The researcher looked for alternative fertilizer instead of superphosphate to meet the needed requirement of lettuce which is 60-60-0. As an alternative the area applied 2.72kg of Ammonium sulfate (16-20-0) and 240g of Urea (46-0-0) for basal application, 8 grams of urea for 1st side dress, and 8g of urea for 2nd side dress. In the application of fertilizer, all treatments were administered in the morning between 8:00 and 9:00 at fair weather conditions. This was the time for stomata opening and better nutrient absorption. Administering the treatment was commence one week after transplanting and was g repeated at a one-week interval.

Weeding Management

Weeding was done at 14 days after transplanting and was repeated depending on the weed population.

Watering Management

Watering of plants was done early in the morning, to allow the foliage to dry out quickly and to avoid diseases.

Cultivation and Care Management

Lettuce has shallow roots. As such it should be hoed and cultivated carefully to ensure rapid development and high-quality product.

Harvesting

Harvest lettuce at 40 days from transplanting. Harvest leaf lettuce as needed. For seed production, when it has reached the maturity of the seeds lettuce was harvested. It can be harvest 60 to 90 days after transplanting.

Data Gathered

Average Plant Height (cm) at Maturity: Ten (10) Representative sample plants from each treatment were selected randomly excluding border rows. Average plant height was measured from the base of the plant up to the highest leaf by using a tape measure.

Average Number of Leaves: Ten sample plants were counted manually. To get the average number of leaves. It will be divided into the number of sample plant in every plot.

Average Leaf Area(cm^2): The largest and smallest leaves per sample plant was measured in graphing paper and count the area of the leaves then add then add the leaf area of smallest and largest leaf then dived by two to get the average of leaf area this was measured using graphing paper.

The weight of Plant at Harvest: The average weight (g) of the plant was taken by adding the weight of ten sample plants per plot within the experimental area then it was divided by the total number of sample plants this was measured using digital weighing balance.

Average Seed Yield: The average weight (g) of seed was taken from the 10 sample plants and divided to the number of sample plants per plot.

Cost and Return Analysis: This was computed based on the actual expenditures (cost of production and cost of materials). The following formulas are used: Net Income is qualed to Gross Income – Total Expenses, to get the ROI the Net Income was divided by the total Expenses.

Statistical Analysis

All the data gathered and were analyzed following the Analysis of Variance for the Completely Randomized Design. Duncan's Multiple Range Test (DMRT) was used for the comparison of means with significant results.

Results and discussion

Observation

Three days after sowing, 90 percent of seeds emerged. During the transplanting of the seedling, heavy rain was occurring for five consecutive days result to some leaves were removed. All plants applied with fermented goat manure exhibited good stand with robust and greener leaves. However, it was observed further that the plants applied with 40 and 50ml fermented goat manure (T3) and (T4) differed in growth and development from the plants in the other treatment. These plants showed excessive and prolific vegetative growth which was noticeable few days after the succeeding application of fermented goat manure. It was observed 45 DAT 100% flowering. The flowers getting matured 12 to 21 days after blooming.

Average Plant Height

The plant height of lettuce at 40 days after transplanting (DAT) as influenced by the different concentration of fermented goat manure is presented in Table 1. Result showed highly significant differences were observe to the plant height, wherein the plants applied with 40ml of fermented goat manure (T3) produced the tallest plants having mean value of 75.33 centimeters followed by the application of 30ml Fermented goat manure (T2) and 50ml Fermented goat manure (T4) with mean value of 71.83 and 72.33 centimeters. Shortest plants were found on the control plants (T1) with the mean value of 68.03 centimeters. Coefficient variation was 0.7438%.

As to the average plant height, plants applied with 40ml of fermented goat manure got the highest plant height which means that the 40ml of fermented goat manure can contribute to the plant height because according to Several studies including Shinohara *et al.* (2011) have demonstrated that using microorganisms to degrade organic nitrogen inorganic sources such as manure results in nitrates and ammonium production which in turn are used for plant production. That's why even the chemical analysis of fermented goat manure have the small amount of nitrogen, there is a microorganism that can help for the nitrogen fixation.

Table 1. Average Plant Height (cm) of Growth and Yield performance of Lettuce Applied with Different Concentrations of Fermented Goat Manure as bio-fertilizer.

Treatments	Plant Height (cm)
T1- Control	68.03 c
T2- 30 ml of Fermented goat manure	71.83 b
T3- 40 ml of Fermented goat manure	75.33 a
T4- 50 ml of Fermented gat manure	72.33 b
ANOVA RESULT	**
C.V. (%)	0.7438

Note: Means with common letter/s are not significantly different from each other using DMRT.

Average Number of Leaves

The Average number of leaves of lettuce as influenced by the different concentration of fermented goat manure is presented in Table 1. Highly significant differences among the treatment means were recorded on the average number of leaves. The highest average number of leaves was obtained by the application of 30ml fermented goat manure (T2) and 40 ml of fermented goat manure (T3) having the mean value ranging from 24.33 to 24.1 centimeters respectively. This was followed by the application of 50 ml fermented goat manure (T4) and Control (T1) having the mean value of 22.97 and 21.9 centimeters. Coefficient variation was 2.54%.

On the average number of leaves plants applied with fermented goat manure with a rate of 30 ml have the highest number of leaves, this result was associated with the findings of Shweta (2008) reported that significantly higher leaf area index (LAI), plant height, number of branches, dry matter accumulation, seed yield and yield parameters like the number of pods per plant with the application of organic manures in combination with liquid organic manures.

Table 2. The average number of leaves of Growth and Yield performance of Lettuce Applied with Different Concentrations of Fermented Goat Manure as bio-fertilizer.

Treatments	Average Number of Leaves
T1- Control	21.9 b
T2- 30 ml of Fermented goat manure	24.33 a
T3- 40 ml of Fermented goat manure	24.1 a
T4- 50 ml of Fermented gat manure	22.97 b
ANOVA RESULT	**
C.V. (%)	2.54

Note: Means with common letter/s are not significantly different from each other using DMRT.

Average Leaf Area (cm^2)

The Average leaf area of lettuce as influenced by the different concentration of fermented goat manure is presented in Table 1. The result showed highly significant differences that the plants applied 50ml of fermented goat manure (T4) grew broadest average leaf area with the mean value of 2514.33cm^2.

Next in rank was the application of 40ml of fermented goat manure (T3) with the mean value of 2419.67cm^2. Followed by the application of 30ml of fermented goat manure (T2) with the mean value of 2276.58cm^2, and control (T1) got the narrowest average leaf area with the mean value of 2178.33cm^2.

The Coefficient variation was .9069%. As to the leaf area, plants applied with fermented goat manure with a rate of 50ml got the highest leaf area. The increasing trend of leaf area also showed that it may be due to the supply of nitrogen from the manure. Nitrogen gave a green color to the leaves and benefited in enhancing all the development of the plant during all the stages. Enough supply of nitrogen also was beneficial to the photosynthesis process. According to Ano and Ubochi (2007) had shown that GM improved N, P, K, Ca, Mg and CEC status of soil and also reduced the exchangeable acidity (EA) of soil that can enhance the growth of plants.

Fresh Weight at Harvest (g)

The Average weight at harvest of lettuce as influenced by the different concentration of fermented goat manure is presented in Table 1.

The highly significant result was revealed on the fresh weight at harvest wherein the heaviest weight at harvest was obtained by the plants applied with a 50ml fermented goat (T4) with a mean value of 231. 98 grams. Next in rank was the application of 40 ml fermented goat manure (T3) with a mean value of 229.12 grams. Followed by the application of 30ml of fermented goat manure (T2) with a mean value of 225.85 grams. The plant with no fermented goat manure (T1) produced the lightest fresh weight at harvest with a mean value of 224.27g. Coefficient variation was 0.3404%.

Table 3. Average leaf Area of Growth and Yield performance of Lettuce Applied with Different Concentrations of Fermented Goat Manure as Bio-fertilizer.

Treatments	Average Leaf Area (cm^2)
T1- Control	2178.33 d
T2- 30 ml of Fermented goat manure	2276.58 c
T3- 40 ml of Fermented goat manure	2419.67 b
T4- 50 ml of Fermented gat manure	2514.25 a
ANOVA RESULT	**
C.V. (%)	0.9069

Note: Means with common letter/s are not significantly different from each other using DMRT.

As to the fresh weight at harvest, the fermented goat manure that was applied with a rate of 50ml got the highest mean. This result was associated with the findings of Gore and Sreenivasa (2011) that the fermented liquid organic manures also contain microbial load and plant growth promoting substances in addition to nutrients that help in improving plant growth, metabolic activities and resistance to pest and diseases. The numerous microorganisms present and growing in the soil is capable of providing all nutrients required by the crop. (Babalad *et al.*, 2008).

Seed Yield (g)

The seed yield of lettuce as influenced by the different concentration of fermented goat manure is presented in Table 1. The result showed no variation among the different treatments on the seed yield with mean values ranging from 31.17 to 35 grams.

The coefficient value registered at 15.34%. Plants sprayed with fermented goat manure with a rate of 30 ml got the highest mean in terms of seed yield these findings were associated with the findings of Thayamini H. Seran and Risvani N.M. Shaherdeen (2013) stated that seeds in goat manure EM-bokashi showed high dry weights of the stem, number of nodules, pod weight and plant biomass. Hence, it could be concluded that the use of animal manure with EM in vegetable cowpea cultivation could give healthy seeds as planting material for obtaining high pod and seed yields and also for favorable health and environment.

Table 4. Fresh Weight at Harvest of Growth and Yield performance of Lettuce Applied with Different Concentrations of Fermented Goat Manure as Bio-fertilizer.

Treatments	Fresh Weight at Harvest (g)
T1- Control	224.27 d
T2- 30 ml of Fermented goat manure	225.85 c
T3- 40 ml of Fermented goat manure	229.12 b
T4- 50 ml of Fermented gat manure	231.98 a
ANOVA RESULT	**
C.V. (%)	0.3404

Note: Means with common letter/s are not significantly different from each other using DMRT.

Table 5. Seed Yield of Growth and Yield performance of Lettuce Applied with Different Concentrations of Fermented Goat Manure as Bio-fertilizer.

Treatments	Seed Yield (g)
T1- Control	34.50
T2- 30 ml of Fermented goat manure	35.00
T3- 40 ml of Fermented goat manure	34.33
T4- 50 ml of Fermented gat manure	31.17
ANOVA RESULT	ns
C.V. (%)	15.34

Cost and Return Analysis

The cost and return analysis 15.75 square meters of lettuce as influenced by the different concentration of fermented goat manure that is shown in Table 2. The return on investment obtained in the different treatments is arranged in descending order. Treatment 4 had 148.59 percent, Treatment 1 had 147.48 and

Treatment 3 had 145.80 percent, the lowest was obtained by Treatment 2 with 142.57 percent.

T_4 (50ml of fermented goat manure) have the highest total production cost at Php. 9,743.3, followed byT_3 (40ml of fermented goat manure) with a total production cost of Php. 9,25.27 also followed by T_2 (30m of fermented goat manure) with a total production cost of Php. 9,485.7and T_1 (Control) as the lowest at Php. 9,419.2. Net income of T_4 gave the highest at Php. 5.823.74, followed by T_3 gave Php. 5,707.84, and also followed by T_1 with the net income of Php. 5, 613.14 and T2 gave the lowest net income of Php.5575.14. This only means that plants treated with goat manure can increase the fresh leaves yield of lettuce. The highest rate of fermented goat manure the highest yield would obtain but we need to control the concentration to avoid burning of crop especially to leafy vegetables.

Table 6. Cost and Return Analysis.

Treatments	Cost of Production		Gross Income		ROI	
	Php	USD	Php	USD	Php	USD
T1- Control	3806.06	$73.19	9419.2	$181.14	147.48	$2.84
T2- 30 ml of Fermented goat manure	3910.56	$75.20	9485.7	$182.42	142.57	$2.74
T3- 40 ml of Fermented goat manure	3915.06	$75.29	9622.9	$185.06	145.80	$2.80
T4- 50 ml of Fermented gat manure	3919.56	$75.38	9743.3	$187.37	148.59	$2.86

Conclusion and recommendation

Generally, this study was conducted to evaluate the efficacy of fermented goat manure as bio-fertilizer on Lettuce *(Lactuca sativa* L.) production. Specifically, it was conducted to evaluate the growth and yield of Lettuce with different concentration of fermented goat manure, to identify the optimum rate of fermented goat manure for lettuce production and to evaluate which of the different concentration of fermented goat manure as biofertilizer has the highest return on investment. The study was conducted at Cagayan State University - Gonzaga, Cagayan from January 17, 2018, to May 5, 2018, The different treatments were used T_1- Control, T_2- 30ml of fermented goat manure per liter of water, T_3- 40ml of fermented goat manure per liter of water and T_4- 50ml of fermented goat manure per liter of water. The experiment was laid out in a single factor Complete Randomized Design (CRD) with four treatments and three replications.

The results of the study are summarized as follows; 1.) A height of the plant at 40 DAT was affected by the application of fermented goat manure. It was observed that the application 40ml of fermented goat manure obtained produced the tallest plants at 40 DAT; 2.) Average number of leaves was attained by application of 30ml and 40ml of fermented goat manure; 3.) Average leaf area was obtained by the plant applied with 50ml fermented goat manure; 4.) Heaviest weight at harvest was achieved by the plant applied with 50ml fermented goat manure; 5.) Seed yield of lettuce was not affected by the application of fermented goat manure; 6.) Highest return on investment was obtained by the application of 50ml of fermented goat manure per 15.75 square meters with 148.59 percent. The application of 30 and 40ml of fermented goat manure per liter produced the tallest plant and the highest number of leaves per sampling area. However, the application of 50ml fermented goat manure per liter of water produced the broadest leaf area and heaviest weight at harvest as well as it obtained the highest return on investment with 148.59 percent. The application of 50ml fermented goat manure per liter of water is recommended because it obtained the broadest leaf area, heaviest weight and highest return on investment. Follow-up study using the same treatment and set up is hereby recommended in order to validate the result.

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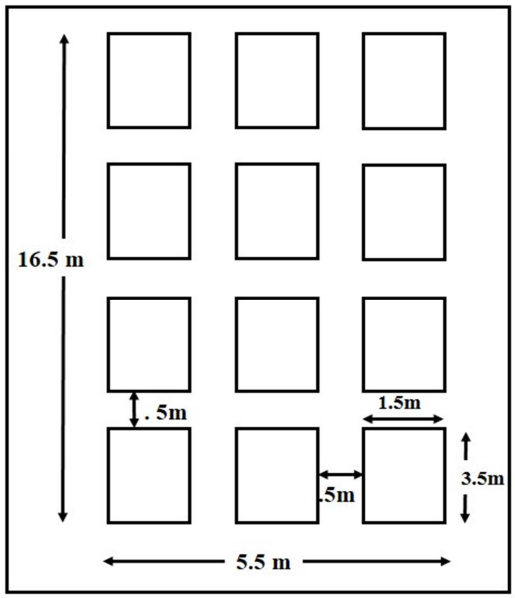
APPENDIX:

Experimental Layout Randomized Complete Block Design**.**



LEGEND:

Treatments:

T1 – Control

T2 – 30 ml of Fermented Goat Manure

T3 – 40 ml of Fermented Goat Manure

T4 – 50 ml of Fermented Goat Manure

Total Area . . . . . 90.75 square meters

Plot Size . . . . . 1.5m x 3.5 m

Distance between Plots . . . 0.5 m

Distance between Blocks . . . 0.5m

APPENDIX C. Procedure in Making Fermented Goat Manure Materials Needed.

1 kg fresh goat manure	Manila paper
2 kg of water	String/ garter
Container or pail	Sack/ net

Procedure:

1. Collect fresh goat manure from goat barn every morning to assure it is fresh.
2. Put the collected manure into the sack and tie it properly.
3. Add water in the pail together with the collected manure.
3. Cover the pail with Manila paper and tie it with a garter to secure.
4. Place the pail in a cool and dry place. Keep away from sunlight and rain. Leave it there for 15 days.
5. After 15 days, separate the liquid from the solids. The liquid is the goat manure tea.

Notes

The ratio of the fresh goat manure and water is 1:2kg. 2 part of water in every 1 part of fresh goat manure.