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RESEARCH

Growth Performance of Lettuce Using Fermented Products as Organic Fertilizers

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ABSTRACT

This study evaluates the growth performance of lettuce (*Lactuca sativa L.)* utilizing various fermented products as organic fertilizers. Growth performance is determined through the plant's weight and leaves and significant differences in growth among various treatments: (a) fish trash, (b) scrap seaweeds, (c) kangkong, and control groups urea (positive) and water (negative) was also determined. Kangkong leaves are fermented for 10 days, fish trash for 14 days and 1 month for seaweeds. Lettuce seeds are sown before transplanting (15 days after germination) into pots and placed in raised beds. Randomized complete block design is utilized in the experiment. Growth performance is measured through the number of leaves 10, 20, and 30 days after transplant and mass of plant upon harvest. After 30 days, the lettuce was harvested. Based on the findings, the soil and fermented products are acidic and the needed organic matter for optimum growth of lettuce are not sufficient as well as some nutrients of the fermented products. Among the organic fertilizers, kangkong at 30 ml performs best in terms of the growth performance of lettuce. Urea performs best in terms of the mass upon harvest. Significant differences exist in the mean number of leaves of lettuce treated with various amounts of organic fertilizers with the plants that receive urea. Lettuce produce more number of leaves and with the highest mass upon harvest when treated with urea compared with organic fertilizers applied after 30 days from transplant.
Keywords: fermented kangkong; fish trash; growth performance; lettuce; scrap seaweeds

INTRODUCTION

Lettuce is a composite plant of the genus Lactuca (*L. sativa*) from the family *Asteraceae* is used mainly in preparation of salads and sandwiches. Its leaves are great source of important nutrients like minerals (Calcium, Iron, Phosporous and Magnesium) and vitamins (A, C, D, E) as well as fiber. They are known for the numerous health benefits they can give like helps fight insomnia, aids in digestion, aids in weight loss and rich in antioxidant and microbial properties.

In the Philippines, lettuce is getting famous as a choice in healthy salads because of its crispness, smooth texture, palatability and nutrient contents. There is an increasing demand for lettuce as it becomes an important ingredient in many diets. It is prepared as a salad combined with carrots, cucumber, tomato, fruits and mixed with dressings.

Organic farming is a fast growing technology in the Philippines. Individuals are embracing the idea that it can help restore the environment from the damage brought by improper soil management practices, intensive crop production and excessive use of inorganic fertilizers and pesticides. Numerous studies were conducted to create and evaluate effective organic fertilizers on the growth and yield of various plants.

One of the emerging techniques used in making organic fertilizers is fermentation. Several organic wastes, plant material and other animal sources are utilized. In this study, the organic fertilizers utilized were fermented fish trash (*Seraloides leptolepis*), scrap seaweeds (*Caulerpa racemosa*), kangkong (*Ipomoea aquatica*) in growing lettuce (*Eton variety*) due to their availability in the local market at a low cost and these fertilizer components may be collected from market vendors for free. The soil used in planting was taken from a rarely planted area in order to evaluate the performance of the fermented products. It was submitted for analysis in the soil laboratory.

This study aimed to determine the growth performance of lettuce using the organic fertilizers, namely, fish trash, kangkong, and scrap seaweeds at 20, 30 and 40 ml in terms of the number of leaves at 10,20 and 30 days after transplant and its mass upon harvest. The significant differences among the growth performance of lettuce treated with the different organic fertilizers and between each treatment and the positive and negative control groups was also determined.

The study's hypotheses: There are no significant differences among the growth performance of lettuce treated with the various organic fertilizers and there are no significant differences in the growth performance of lettuce between each treatment and the positive and negative groups.

METHODS

The study utilized the randomized complete block design. In the study, three organic fertilizers were used at 20, 30 and 40 mL and applied to lettuce plants. There were three plants per amount of fertilizer replicated three times. A positive control group (urea) and negative control group (water only) were also provided. Two

hundred ninety-seven pots (size #10) planted with Eton variety of lettuce were placed in raised beds inside an improvised greenhouse.

In the preparation of fermented products, three kilograms of scrap seaweeds (*Caulerpa racemosa*) thoroughly washed with water and chopped finely was mixed with one kilogram of brown sugar and placed in a plastic container covered with a clean paper secured with a rubber band or a string. Then, it was stored in a cool, dark place for one month and the mixture was filtered using a clean white cloth. Extracted juice was stored in a clean plastic bottle not tightly capped to allow aeration.

The same process was used for the other fermented products, however the amount of sugar, water added, and number of fermenting days vary. Three kilograms of brown sugar and three liters of clean water from a deep well (1:1:1) for fish and three kilograms of brown sugar, 10 liters of deep well water for kangkong. Both were fermented for 14 days.

The fermented products' N, P, K and pH were analyzed at the Central Analytical Services Laboratory, Visayas State University, Baybay City, Leyte. Potentiometric method using a glass electrode was used for pH analysis; Kjeldahl method for total percentage of nitrogen; vanadomolybdate method for total percentage of phosphorus; and aqua regia for organic sample extraction of the total percentage potassium.

Sterilized clay soil was utilized in raising the seedlings in trays. The soil was exposed to direct sunlight for 3 hours (9:00-12:00 noon) to ensure that microorganisms and weeds were eliminated. The soil pH and nutrient (Nitrogen, Phosphorous and Potassium) contents were analyzed at the Regional Soils Laboratory, Tacloban City. The methods used were potentiometric, Walkley and Black, Olsen test, the use ammonium acetate to test pH, organic matter, phosphorous, and exchangeable Potassium.

The fermented organic fertilizers were diluted at 20, 30 and 40 mL per liter of water, drenched to the soil daily at increasing volume as the plant size increased. Three days after transplanting, 50 mL diluted organic fertilizer were added until Day 10. At Days 11 to 14, it increased to 75 mL; at Days 15 – 18, it increased to 100 mL; at Days 19 until 24, it increased to 150 mL. Application was every 6:00 o' clock in the evening. Fertilizers were applied three days after transplanting and four days before harvesting. In the absence of fertilizer application, plants were watered from the artesian well. Three days after transplanting, 50 mL of water was applied and 150 mL of water six days before harvesting.

The commercial fertilizer, 10 mg of urea, was diluted to 1 liter of water per application. The amount of diluted fertilizer was increased as the plant size increased. A diluted solution of 50 mL was drenched to the soil as an initial application. The amount was increased to 75 mL per application until third week. At fourth week, 100 mL diluted solution was applied. Urea fertilizer was applied every 6 o'clock in the evening twice a week three days after transplanting and a week before harvest. In the absence of fertilizers, water from artesian well was applied following the same amounts used for organic fertilizers and with the positive control. The negative control (water) was applied at an increasing amount as well, right after transplanting, 50 mL until Day 10. It was increased to 75 mL at Days 11 to 14; 100 mL at Days 15 to 18 and 150 mL at Days 19 to Day 30. Application was every 6:00 o' clock in the evening. However, every other morning, the plants were watered after transplanting until it was harvested to avoid wilting. Right after transplanting, it was watered with 50 mL until Day 10. Afterwards, it was increased to 75 mL at Days 11 to 14; at Days 15 to 18, it was increased to 100 mL; and 150 mL until Day 30. An organic pesticide made from fermented chili (*Capsicum)*, garlic (*Allium sativum)* and kurot (*Dioscorea hispida Dennst.*) was prepared just in case there were pest attacks. But it is very rare for lettuce to be attacked by pests. Constant weeding was done in order to protect the plants.

To assess growth, average number of leaves and the average mass of fresh plant were measured. The number of leaves were counted and recorded upon transplanting to serve as baseline data, then at 10, 20 and 30 days after transplanting. The mass of fresh plant was measured during harvest using a sensitive digital weighing balance.

Analysis of variance (ANOVA) was used to determine the significant differences of growth performance among treatments and t-test between the experimental and control groups using Microsoft Excel. The acceptance /rejection of the hypothesis was set at 0.01 and 0.05 level of significance.

RESULTS

Table 1. Overall mean number of leaves of lettuce at 10, 20, and 30 days after transplanting

Measurement intervals (days)	Fermented products / amount of extract (mL)										
	Kangkong			Seaweed			Fish trash			Negative control	Positive control
	20	30	40	20	30	40	20	30	40		
10	6.00	**6.07**	5.89	5.96	6.04	5.96	6.04	6.04	5.93	5.77	5.77
20	7.22	**7.29**	6.89	7.04	7.22	7.15	**7.29**	7.15	7.15	6.63	7.15
30	7.78	**8.81**	7.44	7.33	7.96	7.26	7.70	8.33	7.52	6.74	**9.11**

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Table 2. Overall mean mass (grams) of fresh lettuce at harvest

Measurement	Fermented products / amount of extract (mL)										
	Kangkong			Seaweed			Fish trash			Negative control	Positive control
	20	30	40	20	30	40	20	30	40		
Upon Harvest	1.62	**7.57**	0.79	0.94	1.76	0.65	1.90	4.51	0.81	0.67	**12.06**

Table 3. Results of soil analysis before planting

Soil parameters	Adequate value*	Result
Ph	5.5- 8.5	5.09
Organic matter (%)	>4.5	2.76
Available phosphorous (mg/kg)	>20	0.72
Exchangeable potassium (cmol/kg)	>0.25	0.23

*Source: Regional Soils Laboratory, Department of Agriculture

Table 4. pH and nutrient contents of fermented kangkong, seaweed and fish trash extracts

Fertilizers	pH	Total N (%)	Total P (%)	Total K (%)
Fermented fish trash	3.97	1.119	0.368	0.090
Fermented seaweed	3.33	0.084	0.000	0.150
Fermented kangkong	3.32	0.022	0.018	0.020

DISCUSSION

Lettuce treated with 30 mL of fermented kangkong got the highest mean number of leaves at 10, 20, and 30 days after transplant among the organic fertilizers. Although, upon harvest it was urea who got the highest number of leaves. Kangkong is a good source for organic fertilizer production since it was able to cause positive effect on the growth performance of the lettuce plant. According to Borhan (2011) [(1)], water spinach is a good growth promoter as it grows fast and may contain high natural growth hormones such as auxin.

Upon harvest, it was kangkong at 30 ml who got the highest mass among the organic fertilizers but urea got the highest mass in general.

The computed p values for the comparisons of the number of leaves are all higher than the 0.05 level of significance except for those treated with 30 mL extract at 30 days and for the mass of lettuce plants at harvest treated with 30 mL of the extracts. It can be deduced further that the number of leaves and mass of lettuce plants at 30 days after transplant treated with 30 mL of kangkong, seaweed, and fish trash differ significantly from each other. This means that the plants applied with 30 mL of kangkong extract have the highest number of leaves and mass while those treated with 40 mL have the least number of leaves and mass. Moreover, it can be interpreted that among the three extracts, kangkong extract at 30 mL per application produced plants with the highest number of leaves and with the highest mass.

The poor performance of the fermented organic fertilizers is attributed to the lack of valuable nutrients of soil used. The optimum plant growth is dependent on the balance and supply of soil nutrients. The soil used was collected from a rarely planted area. The pH of the soil is 5.09, which means it is acidic. When the soil's pH is in its optimum level, growth of vegetables and plants are maximized. A soil pH of 6 to 6.8, silty clay loam, loam and clay loam soil with high organic matter (good water holding capacity) are best for growing lettuce. It is recommended to mix soil conditioners such as carbonized rice hulls (burned rice hulls) and coconut coir dust to make the soil friable for easy root penetration and water percolation if the soil is clay (heavy/sticky soil). [(2)] It was found out that the macronutrients present in the soil are below the adequate values needed in planting lettuce.

Kangkong (*Ipomoea aquatica*) turned out to be the most acidic and contained the least nitrogen and potassium among the organic fertilizers but it had the highest yield and the number of leaves among the organic fertilizers. Fermented fish trash and seaweed are likewise acidic with fermented fish trash containing highest percentage of total K (Potassium) but does not contain any P (Phosphorus). The growth performance of lettuce could be attributed to the high salinity of the seaweeds and fish trash. High salinity is a major stress factor that restricts crop productivity and majority of the world lettuce production are affected. [(3,4)] In a study conducted, it was identified that turgor reduction affecting the conductance of stomata and cell expansion, growth limitation

due to the rate of photosynthesis; and/ or accumulation of salts or specific ions affecting the production of particular metabolites are the effects of salinity in plant growth. (5)

Literature also indicates that because of the accumulation of Na+ or Cl- in leaves, salt-sensitive plants exposed to high salinity levels, show reduction in leaf photosynthesis, due to disruption in C metabolic pathways and redox reactions in the thylakoid membranes as well as in the Calvin cycle. (6) Fermented fish and seaweeds came from salty environment, their salinity had an effect on their performance as organic fertilizer. Both have sodium content. The presence of salt in the soil solution reduces plant's ability to take up water, leading to growth rate reduction known as osmotic or water-deficit effect of salinity. The salt-specific or ion-excess effect of salinity, if excessive amounts of salt enter the plant in the transpiration stream, it causes injury to cells in the transpiring leaves thus cause further reductions in growth. (7)

The first null hypothesis stating that there is no significant difference in the growth performance of lettuce among the different amounts of extract is accepted in terms of the number of leaves at 10 and 20 days after transplant, but rejected at 30 days after transplant as well as in terms of the mass of plants at harvest. Likewise, no significant difference is observed in the growth performance of lettuce plants among the different organic fertilizers except for the 30 mL extract which showed significant effect on the plant's growth.

However, the results due to fermented kangkong extract specifically the 30 mL extract is noteworthy since it gained the highest mass among the three extracts. This could be attributed to the composition of the kangkong which is of plant origin compared to the seaweed and fish trash. The observed results could be attributed to the nutrients present in the fermented kangkong extract most especially nitrogen which is the most important macronutrient responsible for the overall plant growth. Plants need nitrogen to form amino acids, perform enzymatic reactions and produce the chlorophyll necessary for photosynthesis. Nitrogen affects a plant's leaf development.

Hence, the second null hypothesis stating that there is no significant difference between the growth performance of lettuce treated with the organic fertilizers and that of the control group is accepted in terms of number of leaves at 10 days after transplant using the three organic fertilizers compared to the negative control and at 10 and 20 days after transplant compared to the positive control. But the hypothesis is rejected in terms of the number of leaves at 20 and 30 days after transplant using the three organic fertilizers compared to the negative control and at 30 days compared to the positive control. Furthermore, the hypothesis is also rejected in terms of the mass of plant at harvest when compared to the negative and positive control groups of plants.

CONCLUSION

The soil and fermented products were acidic and the needed organic matter for optimum growth of lettuce were not sufficient as well as some nutrients of the fermented products. The acidity and alkalinity of the soil affected the growth of plants. Among the organic fertilizers, kangkong at 30 ml performed best in terms of the growth performance of lettuce. Urea performed best in terms of the mass upon harvest. Significant differences exist in the mean number of leaves of lettuce treated with various amounts of organic fertilizers with the plants that received urea. Plants produced more number of leaves when treated with urea compared to those with the organic fertilizers after 30 days of transplant. Lettuce treated with urea got the highest mass. It is recommended to use less acidic top soil when applying fermented products for the lettuce's optimum growth. Soil analysis should be done before planting. The amount applied and the interval schedule of application may be modified in further studies to determine at which condition fermented products perform best.

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