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Performance Trial of Vermicompost on the Growth and Yield of Garlic (Ilocos White Shank)

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Key words: Vermicomposting, Plant height, Bulb diameter, Complete randomized design

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Abstract

The garlic (*Allium sativum*) variety "Ilocos white shank" was subjected to two levels of vermicompost application to determine its plant height, bulb diameter, and its yield. Complete Randomized Design (CRD) was used to test the performance of the garlic under two levels of vermicompost application, namely; T_1 – Control (No vermicompost applied); T_2 – Vermicompost @ 2 tons/ha; T_3 – Vermicompost @ 4 tons/ha.Results of the study revealed that the height of garlic plants fertilized with vermicompost at the rate of 20 grams/hill (4 tons/ha) produced the tallest plants with a mean of 62.8 cm, followed by 47.3 cm (2 tons/ha of vermicompost) and the least was observed in the unfertilized plots with a mean of 44.13 cm. The diameter of the garlic bulb produced in the study was greatest at 3.85 cm when fertilized with vermicompost at the rate of 4 tons/ha, followed by 3.37 cm in plants applied at the rate of 2 tons/ha. The yield of garlic, Ilocos white shank is highly favored by the application of vermicompost at the rate of 4 tons per hectare, which gave a mean yield of 3.840 tons/ha, followed by the application rate of 2 tons/ha, which gave a yield of 2.867 tons/ha while the unfertilized plot recorded a yield of 2.707 tons/ha.

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Introduction

Garlic (*Allium sativum*) is the second most widely cultivated bulb crop after onion. It is an indispensable ingredient in the Filipino diet. It gives the characteristic flavor and spicy aroma to sauted viands. A fresh bulb contains about (62.8%) moisture, (0.1%) fat, (and 0.8%) fiber and is a good source of carbohydrates, vitamin C, Selenium, Phosphorous, and Manganese (Roger, 2001). Besides its conventional use, it is commonly used in traditional medicine such as hypertensive, anthelmintics, expectorant and many others, including the growing interest of the farmers as botano-pesticides for growing organic vegetables. Due to its significant uses, demand for this crop is continuously growing.

From the 2,457.50 hectares of land resources of Piat suited to crop production, 50.10% of it is devoted to upland crops such as sugarcane, corn, legumes, root crops, and vegetables. None of which is devoted to garlic production. However, initial findings reveal that garlic can be grown profitably along the sandy clam loam of Piat. On the other hand, garlic, as a nutrient-loving crop, responds well to added fertilizers in the soil, most especially the combined use of organic and inorganic fertilizers. According to the Investment Guide for Garlic of the Department of Agriculture (2019), the average production yield of garlic in 2019 was obtained at 2.78 tons/ha. Furthermore, as cited by Maghirang (2001) in his garlic production guide, the potential yield of Ilocos White Shank in the Philippines is 3.5 tons/ha.

On the other hand, vermicompost is organic material broken down by interaction between earthworms and microorganisms. This material has diverse microbial and enzymatic activity. It has a fine particulate structure, good moisture-holding capacity, and contains nutrients readily taken up by plants. *Allium sativum* has a low capacity to absorb nutrients from soils due to a relatively underdeveloped root system (Babatunde *et al.*, 2009). Hence, for proper plant nourishment and high-quality yield, an adequate and balanced supply of readily available nutrients is essential in cultivating garlic. One of the promising locally produced organic fertilizers is vermicompost. Its favorable characteristic is the slow release of macronutrients and microelements into the soil environment. The elements it contains, such as nitrogen, phosphorus, potassium, calcium, and magnesium, are present in forms that are readily available to plants (Sachin *et al.*, 2017). Furthermore, vermicompost contains a good range of essential micronutrients other than NPK fertilizers, required for healthy plant growth (Surindra, 2009).

The structure of vermicompost is somewhat flaky with high porosity. Thus, promoting good aeration and high-water holding capacity. Vermicomposts also have great potential in maintaining soil fertility as they are a source of phytohormones such as auxins, gibberellins, and cytokinins (Shafeek *et al.*, 2015).

This study serves as a springboard to determine the production rate of garlic in Piat. It likewise aimed to generate data regarding the potential contribution of garlic in terms of income to those who will grow the crop. Moreover, the result of the study will be used as a reference for technology development not only for instruction but also for research and extension. This will also open greater opportunities for diverting the use of vermicompost not only for vegetable production but also for spice crop production.

Generally, this study aimed to determine the performance of vermicompost on the growth and yield of garlic (Ilocos White shank) along Piat condition. Specifically, it aimed to evaluate the response of the said garlic variety as to; (1) plant height; (2) equatorial diameter of the bulb; (3) average weight of bulb; and (4) the projected yield in tons/ha.

Materials and methods

Description of the study area

The municipality of Piat has the highest elevation of 196 meters with the lowest elevation of 13 meters above sea level. However, the experimental area was located at brgy Calaoagan Piat with an elevation of 26.1 meters above sea level. The soil pH of the experimental area is 6.3 and the textural class is Bago sandy clay loam. An area of 185 square meters was cleared, cultivated and formed into different plots. The range of temperature and humidity during the conduct of the study was from 29 to 32^{o}C and 58% to 70%, respectively.

Typically, Piat receives an average of about 180.57 millimeters of precipitation and has 230.79 rainy days annually, or 63.23% of the time, receiving precipitation. This amount of precipitation is far below the required level of the moisture regime.

Description of the Experimental Material

Ilocos White Shank garlic cultivar was used for the study. One kilogram of this cultivar was obtained from a garlic grower in Pasuquin, Ilocos Norte. The fertilizer material, vermicompost, was used as an organic fertilizer supplying the elements needed by the plants. The vermicompost was prepared from cattle manure, kakawate (*Gliricia cepium*), banana bracts, and rice straws were used. A percent composition of 50-10-20-20 was used in the allocation of the substrate. The materials were chopped using a mechanical shredder and the manure was pulverized; then, the materials were mixed together and piled in a bed lined with CHB without compressing, watered then enclosed with a plastic cover. It underwent two weeks (14 days) of thermophilic composting. After 14 days, it was stirred with spading fork and watered by means of the sprinkler. Two days after, two-kilogram of African nightcrawler (*Eudrilus eugeniae*) were placed in a heap and covered with partly decomposed rice straw. Care and management were done during the composting process. Three months later, the substrate in the bed were harvested and mechanical shifter was used to separate the vermicompost from the worms and other undecomposed materials.

Treatments and Experimental Design

The treatments consisted of three rates of vermicompost (0, 2, 4 t ha-1). The experiment was laid out in a randomized complete block design (RCBD) and replicated three times per treatment. All significant pairs of treatment means were compared using the LSD (Least Significant Difference) Test at a 5% level of significance. Nine plots were made measuring 1 m x 3 m each, spaced 0.5 m apart. Soil clods in the plots were turned into fine seedbeds to accommodate the bulbils. Medium (1.5-2.0 grams) cloves or bulbils from bulbs stored for about 6 months with dry tops attached were prepared for planting (Fikreyohannes, 2005). Chosen bulbils were soaked overnight and air-dried for 3 hours prior to planting to break their dormancy.

The experimental plots received vermicompost according to treatments on October 03, 2020, by cutting open furrows and incorporating them into planting rows at a depth of about 10 - 15 cm. One after, planting the cloves were done. Each plot was laid out with 15 hills/row at four rows per plot, thereby accommodating 60 bulbils per plot. However, plots were watered prior to planting. A Dibble stick was used and the soaked bulbils were inserted vertically into the soil with the root plate facing down. The upper one-fourth of the bulbil was left exposed while its ¾ length was firmly pressed into the soil for easier root contact. Two inches thick of rice straw was spread over the surface as mulch over the plot after planting to protect the plots and bulbils from drying up. Extra bulbils were separately planted in plastic trays to replace the dead hills. Ten days after planting, the plots were inspected to help seedlings emerge from the mulch as well as replace the dead plants. Weed control was done by hoeing and shallow earthing up. Other crop management practices, such as water management, were done as required after plant emergence until harvesting. When 70% of the leaves are senesced, harvesting is done. The harvested bulbs were windrowed in the field and sun-dried for ten days, folding the leaves over the bulbs to protect them from sunburn. After a week of drying, the tops and roots were trimmed.

Data Collection and Measurement

At the onset of maturity (90 DAE), 10 hills in the two inner rows were marked as sample plants. The following data was recorded and analyzed;

Plant Height

The height of the plants was measured from the base of the stem up to the tip of the tallest leaf and recorded properly. This was done 90 days after emergence (DAE) using a ruler on the centimeter scale. The average height of plants per treatment was determined by using the formula

$$\text{Plant height} = \frac{\text{total plant height (cm)}}{\text{Total number of plants measured}}$$

Equatorial diameter

Garlic plants were pulled or harvested when the tips of the leaves were partially dried and the leaf blade turned yellow and the stem was softened. Harvesting was done 110 days after planting. The harvested bulbs were sundried for five days before the equatorial diameter and weights of the bulbs were recorded. The diameter of the bulbs was measured with the use of a Vernier Caliper. The average equatorial diameter was computed as follows:

$$\text{Equatorial Diameter} = \frac{\text{Total equatorial diamete}}{\text{Number of bulbs measured}}$$

Weight per Bulb

Dried garlic bulbs from each treatment were weighed and recorded properly. The average weight per bulb was computed as follows:

$$\text{Weight of Bulb} = \frac{\text{Total weight of bulb per plot}}{\text{Number of bulbs weighed}}$$

Yield per Hectare

All harvested bulbs from each treatment were weighed and recorded properly. The yield per hectare was projected based on the yield per plot from each treatment by using ratio and proportion as follows:

$$\frac{\text{Yield per plot (kg)}}{\text{Area per plot, (sq m)}} = \frac{X}{10{,}000\ \text{sq. m}}$$

Results and discussion

General observations

The garlic, specifically Ilocos white shank, has five to seven leaves arranged alternately on the shank. Its leaf has an average width of 0.5 to 1.2 cm and a length of 40 to 62 cm long and the leaf color ranges from light to dark green. Plants in T_3 (fertilized with 20 grams/hill) had the most lustrous leaves, while the unfertilized plants exhibited dull leaves.

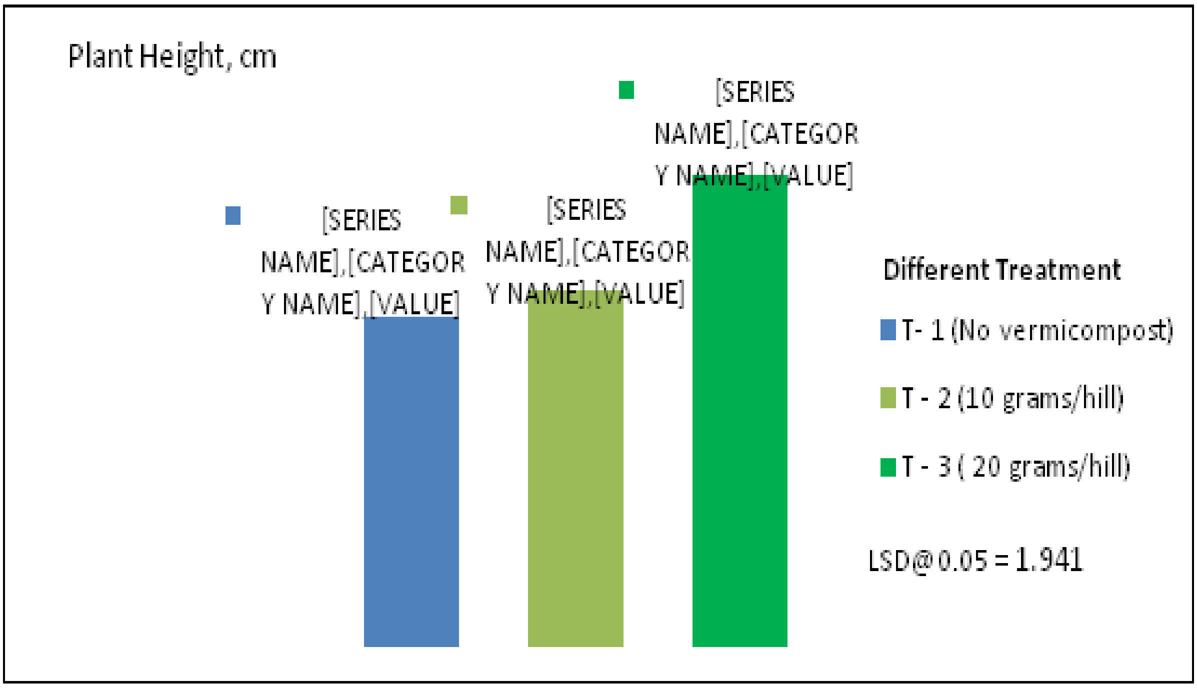

Fig. 1. Response of garlic (Ilocos White Shank) in terms of plant height as influenced by two levels of vermicompost.

The bulbils in the plot started germinating on the third day after planting but completed their germination 9 DAP. There were 40 bulbils that did not germinate and were replanted on the tenth day. During the growing season, rain intermittently occurred; hence watering was done using a manual sprinkler when it was needed. No insect pests were observed in the plants during the growing season.

However, there were leaf spots observed among the plants grown in the unfertilized plots. The growing period lasted for 110 days.

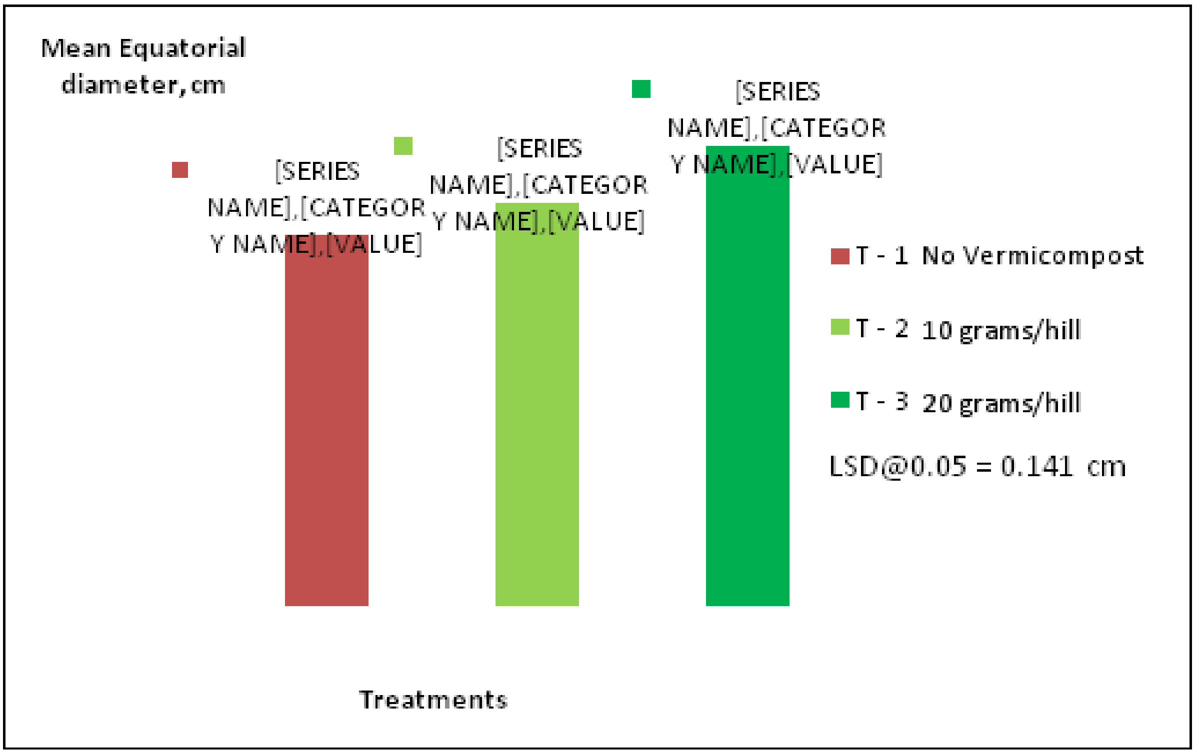

Fig. 2. Response of garlic (Ilocos white shank) in terms of its bulb equatorial diameter as affected by different levels of vermicompost application.

Plant Height

Fig. 1 shows that the height of garlic plants at maturity was greatly affected by the application of organic fertilizer. Plants fertilized with vermicompost at the rate of 20 grams/hill (4 tons/ha) produced the tallest plants with a mean of 62.8 cm, followed by 47.3 cm (2 tons/ha of vermicompost) and the least was observed in the unfertilized plots with a mean of 44.13 cm. Statistically speaking, vermicompost significantly influenced the height of the plants; hence it is a good organic fertilizer for garlic despite its low NPK content.

The increased rate of vermicompost gave a corresponding increase in height which may be attributed to the fact that vermicompost contains a good range of essential micronutrients required for healthy plant growth, although it contains a small amount of NPK (Surindra, 2009). This Author further revealed that the application of vermicompost increased the budget of essential soil micronutrients and promoted microbial population, which ultimately promotes plant growth and production on a sustainable basis. Although the elemental nitrogen, phosphorus, potassium, calcium, and magnesium are present in small amounts, they are in ionic forms that are readily available to plants (Sachin *et al.*, 2017). In a similar study, Mehdi *et al.* (2012) also reported that vermicompost showed more vigorous growth of lettuce seedlings as a consequence of the optimization of the use of water and carbon. An increase in the leaf area index increases light interception and the source/sink strength for heat, water and CO_2 exchange.

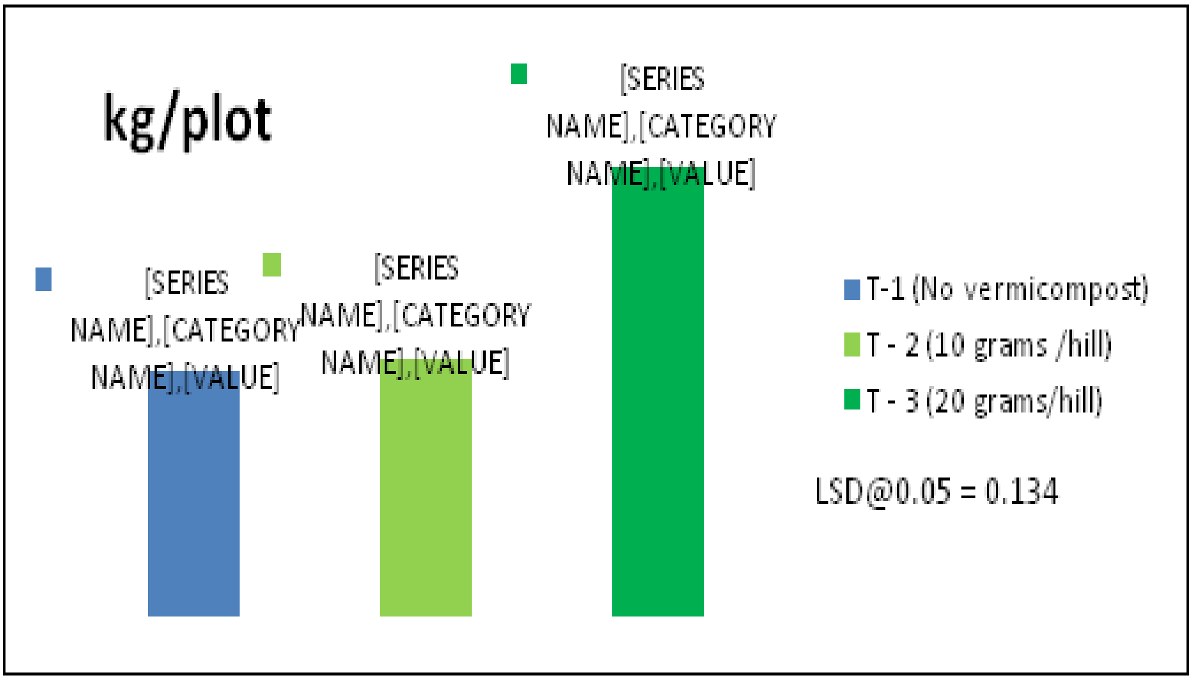

Fig. 3. Weight of garlic (Ilocos white shank) as influenced by two levels of vermicompost application.

Equatorial Diameter (ED)

The diameter of the garlic bulb produced in the study was greatly influenced by vermicompost application. Fig. 2 reveals that rate of 20 grams/hill (4 tons/ha) gave the highest equatorial diameter of 3.85 cm, followed by 3.37 cm when applied at the rate of 10 grams/hill (2 tons/ha). Analysis of Variance revealed that treatments were highly significant from each other. As noticed in the result of the study, more bulbils or cloves are seen in the bulb when its diameter is bigger.

This observation runs contrary to the Taiwan white variety of garlic that once the diameter is bigger, the size of individual cloves is also bigger, but the number of bulbils is less. Hence, the rate of 4 tons/ha is highly appropriate to affect a better bulb diameter when using the Ilocos White shank variety.

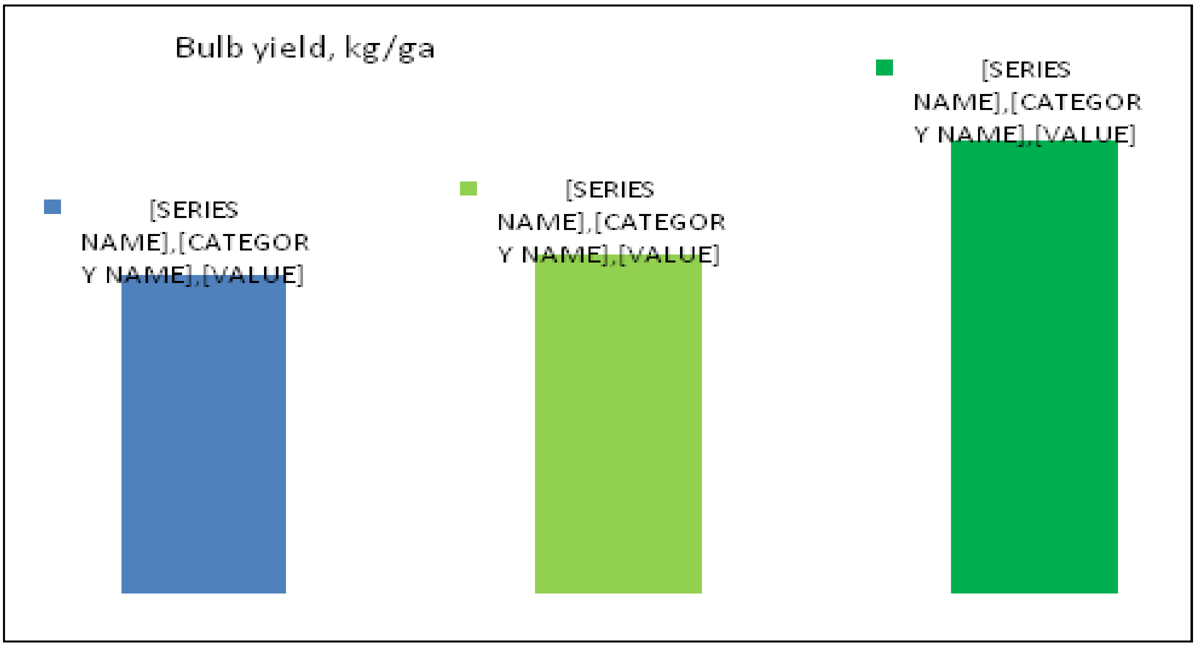

Fig. 4. Projected bulb yield (kg/ha) of garlic (Ilocos White shank) as affected by two levels of vermicompost

A study by Surindra (2009) showed that an integrated nutrient supply of traditional inorganic NPK in ionic form brings an excellent biochemical change in soil structure, which ultimately promotes plant growth and production. Moreover, the earthworm casts not only affect soil's physio-chemical structure but also promote its biological properties of it.

Bulb Yield, kg/Plot

The performance of Ilocos white shank garlic is highly favored by the application of vermicompost. Fig. 3 shows that the rate of applying 4 tons of vermicompost per hectare gave a mean yield of 2.99 kg/plot, followed by the application rate of 2 tons/ha, which gave a yield of 3.37 kg/plot, while the unfertilized plot recorded a yield of 1.624 kg/plot. Statistics revealed that treatments were highly significant from each other.

The increased mean bulb weight could be due to the role of vermicompost, which is known to contain micronutrients apart from major nutrients. Besides this, vermicompost has been reported to contain several plant growth promoters, enzymes, beneficial bacteria and mycorrhizae (Gupta, 2005). Earthworm castings (worm manure) are rich in microbial activity and plant growth regulators and fortified with pest-repellence attributes as well (Suparno *et al.*, 2013).

Fig. 5. Close-up view of the research area.

Bulb Yield/ha

Fig. 4 shows the application of vermicompost from 0-4 t/ha gave an increase of 41.85%. The increase in marketable bulb yield in response to the increasing rate of vermicompost may be ascribed to the availability of optimum nutrients contained in manure that may have led to improved leaf growth and photosynthesis (Mehdi *et al.*, 2012).

Based on the data per plot, it can be deduced that T_3 (3.840 tons/ha) gave a tremendous difference as compared to T_2 and T_1, which gave a yield of 2.867 tons/ha and 2.707 tons/ha, respectively. The result of the study surpassed the data cited by Dela Cruz using the same garlic variety for Bicol (3.46 mt/ha); Central Visayas (3.26 mt/ha); Central Luzon (2.79 mt/ha); but not for Ilocos Region (3.98 mt/ha) and Southern Tagalog Region which is 4.22 mt/ha. In as much that this is an initial study; it needs to be verified further

Conclusion

Based on the results of the study, the use of vermicompost as a basal fertilizer is an important approach to increasing the income of garlic farmers against fertilizer. The research findings followed a linear relationship which tells us that within the limits of the study, a higher rate of vermicompost produces a greater yield of "Ilocos white shank" garlic. Vermicompost applied at 4 tons/hectare significantly influenced the height of the plants; gave a better bulb diameter and greater bulb yield when using the Ilocos White shank variety; hence it is a good organic fertilizer for garlic despite its low NPK content.It is, therefore, highly recommended to use vermicompost at the rate of 4 tons/ha in garlic production using the Ilocos white shank variety.

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