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Productivity of watermelon (*Citrullus lanatus* L.) in biochar-amended soil

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Key words: Watermelon, Biochar, Inorganic fertilizer, Return on investment, Pelletized biochar

Abstract

The study was conducted to evaluate the performance of watermelon applied with pelletized biochar. Specifically, it aimed to determine the effect of biochar on chemical composition of the soil, determine the effect of biochar on the growth and yield of watermelon, and compute the return of investment of watermelon applied with pelletized biochar. The experiment was conducted from January 30, 2022 to April 07, 2022 at the experimental area of the Institute of Agricultural Technology, Isabela State University, Cauayan Campus, Cauayan City. The different treatments used were: T1- 20-0-0 kg NPK ha-1 (RR based on soil analysis), T2- 10-0-0 kg NPK ha-1 (1/2 RR), T3-20-0-0 kg NPK ha-1 + Pelletized Biochar (3 tons/ha), T4- 10-0-0 kg NPK ha-1 + Pelletized Biochar (3 tons/ha), T5- 3 tons Pelletized Biochar ha-1. The experiment was laid out in Randomized Complete Block Design with three replications. The application of pelletized biochar along with inorganic fertilizer on watermelon improved the chemical properties of the soil. It increased the pH level of the soil and enhanced the availability of macro and micronutrient after it was amended with different biochar. Application of pelletized biochar along with inorganic fertilizer on watermelon production can produced optimum yield and enhanced the growth of the plants. Production of watermelon using biochar in combination with inorganic fertilizer enhanced the return of investment. Based on the result of the study, the following were recommended: The application of pelletized biochar along with inorganic fertilizer was recommended because it enhanced the soil pH, macro and micronutrients of the soil and produced attainable fruit yield. The pelletized biochar as organic soil amendment in combined with inorganic fertilizer was recommended because it improved the growth and yield of watermelon. The pelletized biochar as organic soil amendment along with inorganic fertilizer was recommended because it enhanced the return of investment.

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Introduction

Biochar has very different properties as well as stability depending on the feedstock and generation procedures used (Graber *et al.*, 2014). Most attention to date has focused on biochar's effects on plant growth responses to varied biochar amendment (Gathorne-Hardy *et al.*, 2009; Van Zwieten *et al.*, 2010; Abrishamkesh *et al.*, 2015). There is paucity of information of biochar effects on vegetable crops (Elmer and Pignatello, 2011; Ghosh *et al.*, 2015), indicating a need to generate robust understanding of how biochar can be effectively used in vegetable crop production.

Biochar's effects on crop yield have been mainly attributed to soil chemical and biological responses, including greater amounts of plant available water (Jeffery *et al.*, 2011), increased cation exchange capacity (CEC) and enhanced retention of basic nutrients (Lehmann *et al.*, 2003), and greater pH and base saturation (Lehmann *et al.*, 2003). Moreover, biochar has also been shown to affect soil enzyme activity and soil microbial community composition and abundance (Lehmann *et al.*, 2011). Biochar amendment usually increases the soil enzyme activities involved in nitrogen (N) and phosphorus (P) cycles but reduces the soil enzyme activities related to carbon (C) cycle (Bailey *et al.*, 2011).

Biochar is a simple solution to alleviate the environmental problems and concurrently increase crop yield. Liu *et al.* (2013) and Jeffery *et al.* (2011) reported that biochar increased crop productivity by 11% in a variety of crops. According to (Agegnehu *et al.* 2017), crop biomass and yield have been increased. The soil was the main factor for crop yield changes due to the application of biochar.

The study was conducted to evaluate the effect of biochar on chemical composition of the soil and productivity watermelon.

Materials and methods

Climatic data

The weekly average rainfall (mm), mean maximum and minimum temperature (°C) as well as relative humidity (%) at 8:00 in the morning and 2:00 in the afternoon from planting to harvesting were presented in Fig. 1.

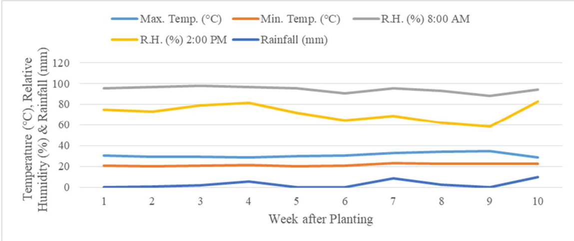

Fig. 1. Climatic data during the conduct of the study Source: Philippine Astronomical and Geophysical Services Administration (PAGASA) agro meteorology station, ISU, Echague, Isabela

Procurement of seeds

The seeds of watermelon (Yellissimo F_1) secured from Condor Seed Company thru their agricultural technician Armando Gabatin was used in the study.

Soil sampling and analysis

Soil samples were randomly collected within the experimental area with the use of shovel before land preparation. The soil samples were spread in a cleaned sack, pulverized and inert material was removed. A one-kilogram composite soil sample was submitted at the Integrated Laboratory of the Cagayan Valley Research Center for analysis. The result of the analysis in terms of NPK, and pH of the soil was the basis for fertilizer recommendation.

Securing of pelletized biochar

The pelletized biochar was derived of rice straw from Center of Organic Agriculture for Research and Extension Training., Isabela State University, Echague, Isabela.

Land preparation

The area was cleaned before plowing. The area was left idle for two weeks to allow weeds to decay and allow weed seeds to germinate before the final plowing. Final harrowing was done before transplanting until the soil was thoroughly pulverized.

Experimental treatments

The following treatments used in the study are the following:

T_1–20-0-0 kg NPK ha^{-1} (RR based on soil analysis)

T_2–10-0-0 kg NPK ha^{-1} (½ RR)

T_3–20-0-0 kg NPK ha^{-1} + pelletized biochar (3 tons/ha)

T_4–10-0-0 kg NPK ha^{-1} + pelletized biochar (3 tons/ha)

T_5 –3 tons pelletized biochar ha^{-1}

Experimental layout and design

After the land preparation, an area of 448 square meters was divided into three blocks, each block measuring 4 meters by 32 meters with an alleyway of one meter between block. Each block was further subdivided into five plots, each plot measuring 4 meters by 6 meters with an alleyway half meter between plots. The treatments were arranged following the procedure in the form of Randomized Complete Block Design (RCBD).

Installation of plastic mulch

Black polyethylene mulch was installed in each plot before transplanting to increase the soil temperature, conserves moisture, and control weeds.

Application of fertilizer

The computed amount of fertilizer per treatment was applied prior to planting and the remaining amount was applied as side-dressed at 25 days after planting.

Planting

Plant two seeds of watermelon per hill with a distance of 60 cm by 100 cm between row and hill. Replanting of missing hills was done five days after planting.

Care and management

Cultivation: Cultivation was done using hand tools.

Crop protection: The occurrence of insect pests was applied using application of insecticide based on recommended rate.

Irrigation: Artificial irrigation was done if no rainfall occurs.

Harvesting: Watermelon was harvested when the fruit reached physiological maturity, indicated by the browning of the tendrils near the fruit.

Data gathered

Chemical properties of the soil before and after the experiment, such as soil pH, organic matter content, macronutrient (NPK), micronutrient (Zn, Cu, Mn, and Fe), and growth and yield parameters like length of vine, weight per fruit, fruit diameter, and fruit yield per plot were taken.

Statistical analysis

The data collected were analyzed using the Analysis of Variance for Randomized Complete Block Design while the part of the sensory evaluation was used the analysis of variance in complete randomized design. The Least Significant Differences was used in case of significant result. Statistical tool for agricultural research (STAR) was used for the statistical analysis of the data.

Cost and return analysis

The return on investment of producing watermelon was computed using simple economic analysis. The cost of production was based on prevailing price of farm inputs and labor. The gross income was determined based on the existing price of watermelon per kilogram in the market. The net income is equal to the gross income minus the cost of production. The return of investment was computed by dividing the net income with the cost of production then multiplied by 100.

Results and discussion

Effect of pelletized biochar on selected properties

Soil properties before biochar application

The chemical composition of the soil before amended with biochar was presented in Table 1. The pH of the soil used in the experiment is 5.93 which is described as "slightly acidic". Soil pH is a measure of the acidity or basicity of a soil and specifically affects plant nutrient availability by controlling the chemical forms of the different nutrients and influencing the chemical reactions they undergo.

Table 1. Chemical composition of soil before amended with biochar

Chemical properties	Level	Qualitative description	Range
Soil pH	5.93	Slightly acidic	5.5 - 8.5
Organic matter (%)	3.64	Medium	> 3.00 %
Available P (ppm)	35.64	Medium	> 30 ppm
Exchangeable K (ppm)	195.42	Medium	> 240 ppm
Zn (ppm)	4.97	Very low	20- 100 ppm
Cu (ppm)	2.64	Low	5-20 ppm
Mn (ppm)	159.94	Medium	20-300 ppm
Fe (ppm)	92.59	Low	50-250 ppm

Watermelon grows best where soil pH is between 6.0 and 6.8. Soil pH affects the amount of nutrients and chemicals that are soluble in soil water, and therefore the amount of nutrients available to plants. For most plants, the ideal soil pH is slightly acid or alkaline.

The pH of the soil used in the experiment is 5.93 described as “slightly acidic”. Soil pH is a measure of the acidity or basicity of a soil and specifically affects plant nutrient availability by controlling the chemical forms of the different nutrients and influencing the chemical reactions they undergo.

Organic matter content is considered “medium” at 3.64 percent. Sustainable crop production can only be attained when soils contained 3.44 percent organic matter. The sustainability is achieved because SOM above 3.64 percent stabilizes the soil structure, decreases bulk density and promotes heightened nutrient cycling. Soils with SOM content of 2.06 percent were susceptible to degradation.

The critical limit of the soil available P for crop production is 10 ppm. This means that the soil (35.64 ppm) contained “low” amount P which is below the critical limit. Potassium aids the plant in using water efficiently, preventing many diseases and heat damage. Potassium helps cycle nutrients through leaves, roots, and stems. The soil in the study contains “moderate” amount of potassium at 195.42 ppm.

Table 2. Soil pH after biochar application

Treatments	Soil pH	Qualitative description
T_1 – 20-0-0 kg NPK ha^{-1}	6.54	Slightly acidic
T_2 – 10-0-0 kg NPK ha^{-1}	6.39	Slightly acidic
T_3 – 20-0-0 kg NPK ha^{-1} + Pelletized Biochar	6.39	Slightly acidic
T_4 – 10-0-0 kg NPK ha^{-1}+ Pelletized Biochar	6.29	Slightly acidic
T_5 – Pelletized Biochar	6.32	Slightly acidic

Effect of biochar on soil ph after harvest

The pH level of the soil after amended with biochar was presented in Table 2. After application of biochar to the soils, the biochar amended soil had a significantly higher in terms of soil pH. It increased from 5.93 (Original soil pH) to 6.39 (20-0-0 NPK ha^{-1} + Pelletized Biochar) and 6.32 (Pelletized Biochar). From the original soil pH 5.93 percent, there was strong evidence that biochar application enhanced the pH of the soil.

Study of Mensah *et al.* (2018) who found out that the application of biochar on the soil improve or enhance the soil pH. This property of biochar is important to increase the soil CEC (cation exchange capacity) when biochar is added to soil. The liming power of biochar depends basically on its ashes content, which is not really biochar but one of its fractions (mineral fraction). Ash content of biochar is very variable and depends on the substrates, in this study – cacao pods and corn cobs. The liming effect of the biochar ashes depends on its bases content (Ca, Mg, K and Na). Some biochar has high ash content but sometimes not too much bases, but Si (as some grass) or Fe (if the feedstock is contaminated by soil or sediments).

Soil organic matter

The organic matter content of the soil after it was amended with biochar was presented in Table 3. Soil amended with biochar decreased the soil organic matter from 3.64% to 3.61 % (20-0-0 kg NPK ha^{-1} + Pelletized Biochar), 3.51% (10-0-0 kg NPK ha^{-1} + Pelletized Biochar), and 3.37% (Pelletized Biochar).

The study is contrary with the findings of Schnee *et al.*, 2021 that sustainable soil amelioration is best achieved by improving biological activity, resulting in enhanced soil organic matter (SOM) stocks.

Table 3. Organic matter content (%) of soils after biochar application

Treatments	Organic matter (%)
T_1 – 20-0-0 kg NPK ha^{-1}	3.38
T_2 – 10-0-0 kg NPK ha^{-1}	3.63
T_3 – 20-0-0 kg NPK ha^{-1} + pelletized biochar	3.61
T_4 – 10-0-0 kg NPK ha^{-1}+ pelletized biochar	3.51
T_5 – Pelletized biochar	3.37

Available phosphorus

The available Phosphorus of the soil after amended with biochar was presented in Table 4. The biochar amended soil had a significant increase in Phosphorus content from 35.64% ppm to 40.10 ppm (20-0-0 kg NPK ha^{-1} + pelletized biochar), 43.60 ppm (10-0-0 kg NPK ha^{-1}+ pelletized biochar) and 39.06 ppm (pelletized biochar).

In general, the application of biochar has the potential to improve the availability of phosphorus of an acidic soil. Based on the result, phosphorus availability in soil could be enhanced with biochar application regardless of the source substrate.

The function of phosphorus in plants is very important. It helps a plant convert other nutrients into usable building blocks with which to grow. Phosphorus is one of the main three nutrients. Phosphorus is one of the most important elements for plant growth and metabolism. It plays key roles in many plant processes such as energy metabolism, the synthesis of nucleic acids and membranes, photosynthesis, respiration, nitrogen fixation and enzyme regulation (Raghothama, 1999). Adequate phosphorus nutrition enhances many aspects of plant development including flowering, fruiting and root growth.

Table 4. Available phosphorus (ppm) of soils after biochar application

Treatments	Phosphorus (ppm)
T_1 – 20-0-0 kg NPK ha^{-1}	42.00
T_2 – 10-0-0 kg NPK ha^{-1}	35.52
T_3 – 20-0-0 kg NPK ha^{-1} + pelletized biochar	40.10
T_4 – 10-0-0 kg NPK ha^{-1}+ pelletized biochar	43.60
T_5 – pelletized biochar	39.06

Table 5. Exchangeable potassium (ppm) of soils after biochar application

Treatments	Potassium (ppm)	Difference
T_1 – 20-0-0 kg NPK ha^{-1}	189.05	----
T_2 – 10-0-0 kg NPK ha^{-1}	187.68	-1.37
T_3 – 20-0-0 kg NPK ha^{-1} + pelletized biochar	230.97	41.92
T_4 – 10-0-0 kg NPK ha^{-1}+ pelletized biochar	171.28	-17.77
T_5 – Pelletized Biochar	161.11	-27.94

Available potassium

The exchangeable Potassium of the soil after amended with biochar was presented in Table 5. The soil amended with Pelletized Biochar plus 20-0-0 kg NPK ha^{-1} had a significantly higher Potassium content with 230.97 ppm. However, the remaining treatments decreased from 195.42 ppm to 189.05 ppm (20-0-0 kg NPK ha^{-1}+ Pelletized Biochar), 187.68 ppm (10-0-0 kg NPK ha^{-1}), 171.28 ppm (10-0-0 kg NPK ha^{-1}+ Pelletized Biochar), and 161.11 ppm (Pelletized Biochar).

Available zinc

The zinc content of the soil after amended with biochar was presented in Table 6. The application of 20-0-0 kg NPK ha^{-1} + Pelletized Biochar, 10-0-0 kg

NPK ha^{-1}+ Pelletized Biochar, and 20-0-0 kg NPK ha^{-1} had significantly higher zinc content by 3.21 ppm, 1.91 ppm, and 1.61 ppm.

Available copper

The copper content of the soil after amended with biochar was presented in Table 7. The soil amended with biochar significantly affects the copper content of the soil. It increased from 2.64 ppm to 3.74(20-0-0 kg NPK ha^{-1}), 3.16 ppm (10-0-0 kg NPK ha^{-1}), 3.34 ppm (20-0-0 kg NPK ha^{-1} + Pelletized Biochar), and 3.01 ppm (Pelletized Biochar). There was strong evidence that the application of biochar enhanced the copper content.

Table 6. Zinc (ppm) content of soils after biochar application

Treatments	Zinc (ppm)
T_1 – 20-0-0 kg NPK ha^{-1}	6.58
T_2 – 10-0-0 kg NPK ha^{-1}	4.45
T_3 – 20-0-0 kg NPK ha^{-1} + pelletized biochar	8.18
T_4 – 10-0-0 kg NPK ha^{-1}+ pelletized biochar	6.88
T_5 – Pelletized Biochar	4.45

Table 7. Copper (ppm) content of soils after biochar application

Treatments	Cu (ppm)
T_1 – 20-0-0 kg NPK ha^{-1}	3.74
T_2 – 10-0-0 kg NPK ha^{-1}	3.16
T_3 – 20-0-0 kg NPK ha^{-1} + pelletized biochar	3.34
T_4 – 10-0-0 kg NPK ha^{-1}+ pelletized biochar	3.23
T_5 – pelletized biochar	3.01

Available manganese

The manganese content of the soil after amended with biochar was presented in Table 8. The application of biochar did not affect the manganese content of the soil. From the original 159.94 ppm, it decreased to 121.18 ppm (20-0-0 kg NPK ha^{-1} + Pelletized Biochar), 125.26 ppm (10-0-0 kg NPK ha^{-1}), 126.85 ppm (20-0-0 kg NPK ha^{-1} + Pelletized Biochar), 144.41 (10-0-0 kg NPK ha^{-1}+ Pelletized Biochar), and 155.39 ppm (Pelletized Biochar). Some scholars also obtained that the improvement on soil chemical properties with biochar was one of the reasons for the augment of soil adsorption capacity towards heavy metals via correlation analysis (Gondek *et al.,* 2016; Liang *et al.*, 2017; Hailegnaw *et al.,* 2020).

Table 8. Manganese (ppm) content of soils after biochar application

Treatments	Mn (ppm)
T_1 – 20-0-0 kg NPK ha^{-1}	121.18
T_2 – 10-0-0 kg NPK ha^{-1}	125.26
T_3 – 20-0-0 kg NPK ha^{-1} + pelletized biochar	126.85
T_4 – 10-0-0 kg NPK ha^{-1}+ pelletized biochar	144.41
T_5 – Pelletized Biochar	155.38

Available iron

The Iron content of the soil after amended with biochar was presented in Table 9. Application of biochar to the soil did not affect the Iron content. From the original content of 92.59 ppm, it decreased to 72.24 ppm (20-0-0 kg NPK ha^{-1}), 69.03 ppm (10-0-0 kg NPK ha^{-1}), 75.67 ppm (20-0-0 kg NPK ha^{-1} + Pelletized Biochar), 76.17 ppm (10-0-0 kg NPK ha^{-1}+ Pelletized Biochar), and 74.43 ppm (Pelletized Biochar).

Length of vine (cm)

The length of vine (cm) as influenced by pelletized biochar was presented in Table 10. The plants applied with pelletized biochar at three (3) tons with 50% of inorganic fertilizer showed the longest vine at 536.33 cm then followed by (T_1) with 455.67 cm, (T_4) 429.00 cm and (T_2) 407.67 cm. the shortest vines were obtained in the plants applied with sole pelletized biochar with 285.00 cm. This indicates that biochar is effective in enhancing the length of vines if applied along with inorganic fertilizer. Further, sole application of pelletized biochar had no significant effect in increasing vine length.

Weight per fruit (kg)

The weight per fruit of watermelon was significantly affected by different treatment as presented in Table 11. The plants applied with pelletized biochar at three (3) tons with 50% of inorganic fertilizer showed the heaviest fruit with 3.48 kg then followed by (T_1) with 2.49 kg, (T_4) 2.31 kg and (T_2) 2.06 kg. However, the lightest fruit were obtained in the plants applied with sole pelletized biochar with 1.05 kg. This indicates that the biochar is effective in enhancing the weight per fruit if applied along with inorganic fertilizer. Further, sole application of pelletized biochar had no significant effect in enhancing weight per fruit.

Table 9. Iron (ppm) content of soils after biochar application

Treatments	Fe (ppm)
T_1 – 20-0-0 kg NPK ha^{-1}	72.24
T_2 – 10-0-0 kg NPK ha^{-1}	69.03
T_3 – 20-0-0 kg NPK ha^{-1} + pelletized biochar	75.67
T_4 – 10-0-0 kg NPK ha^{-1}+ pelletized biochar	76.17
T_5 – Pelletized Biochar	74.43

Means with the same letter are not significantly different with each other using Tukey's honestly significant difference (HSD) test.

Table 10. Length of vine (cm) of watermelon as affected by application of pelletized biochar

Treatments	Length of vine (cm)
T_1 – 20-0-0 kg NPK ha^{-1}	455.67^b
T_2 – 10-0-0 kg NPK ha^{-1}	407.67^b
T_3 – 20-0-0 kg NPK ha^{-1} + pelletized biochar	536.33^a
T_4 – 10-0-0 kg NPK ha^{-1}+ pelletized biochar	429.00^b
T_5 – Pelletized Biochar	285.00^c
ANOVA result	**
C.V. (%)	8.43

Means with the same letter are not significantly different with each other using Tukey's honestly significant difference (HSD) test.

Table 11. Weight per Fruit (g) of watermelon as affected by application of pelletized biochar

Treatments	Weight per fruit (kg)
T_1 – 20-0-0 kg NPK ha^{-1}	2.49^b
T_2 – 10-0-0 kg NPK ha^{-1}	2.06^b
T_3 – 20-0-0 kg NPK ha^{-1} + pelletized biochar	3.48^a
T_4 – 10-0-0 kg NPK ha^{-1}+ pelletized biochar	2.31^b
T_5 – Pelletized Biochar	1.05^c
ANOVA RESULT	**
C.V. (%)	12.86

Means with the same letter are not significantly different with each other using Tukey's honestly significant difference (HSD) test.

Fruit diameter (cm)

The fruit diameter of watermelon was significantly affected by different treatment as presented in Table 12. The plants applied with pelletized biochar at three (3) tons with 50% of inorganic fertilizer showed the thickest fruit with 14.48 cm followed by (T_1) with 12.85 cm, (T_4) and (T_2) obtained a mean value of 10.75 cm, and 10.03 cm respectively. However, the least value obtained in (T_5) with 8.03 cm. Result showed that biochar is effective in enhancing the fruit diameter of watermelon if applied along with inorganic fertilizer. Further, sole application of pelletized biochar had no significant effect in enhancing fruit diameter.

Fruit weight per plot (kg)

The weight of fruit per plot was significantly affected by different treatment as presented in

Table 13. The plants applied with pelletized biochar at three (3) tons with 50% of inorganic Fertilizer showed the heaviest fruit per plot with 102.08 kg followed by T_2, and T_4 with a mean of 62.12 kg and 57.87 kg respectively. The T_2 obtained 51.63 kg. However, the least value obtained in T_5 with 28.29 kg result showed that the application of biochar is effective in enhancing the fruit weight per plot of watermelon if applied along with inorganic fertilizer. Furthermore, sole application of pelletized biochar had no significant effect in increasing fruit weight per plot.

Table 12. Fruit diameter (cm) as affected by application of pelletized biochar

Treatments	Fruit diameter (cm)
T_1 – 20-0-0 kg NPK ha^{-1}	12.85^{b}
T_2 – 10-0-0 kg NPK ha^{-1}	10.03^{c}
T_3 – 20-0-0 kg NPK ha^{-1} + pelletized biochar	14.48^{a}
T_4 – 10-0-0 kg NPK ha^{-1} + pelletized biochar	10.75^{c}
T_5 – Pelletized Biochar	8.03^{d}
ANOVA result	**
C.V. (%)	3.76

Means with the same letter are not significantly different with each other using Tukey's honestly significant difference (HSD) test.

Table 13. Fruit yield (kg) per plot of watermelon as affected by application of pelletized biochar

Treatments	Fruit weight per plot (kg)
T_1 – 20-0-0 kg NPK ha^{-1}	62.12^{b}
T_2 – 10-0-0 kg NPK ha^{-1}	51.63^{c}
T_3 – 20-0-0 kg NPK ha^{-1} + Pelletized Biochar	102.08^{a}
T_4 – 10-0-0 kg NPK ha^{-1}+ Pelletized Biochar	57.87^{bc}
T_5 – Pelletized Biochar	28.29^{d}
ANOVA RESULT	**
C.V. (%)	3.76

Means with the same letter are not significantly different with each other using Tukey's honestly significant difference (HSD) test.

Table 14. Computed fruit yield per hectare as affected by pelletized biochar

Treatments	Projected fruit weight per hectare (kg)
T_1 – 20-0-0 kg NPK ha^{-1}	25,883.33
T_2 – 10-0-0 kg NPK ha^{-1}	21,512.50
T_3 –20-0-0 kg NPK ha^{-1}+ Pelletized Biochar	42,533.33
T_4 – 10-0-0 kg NPK ha^{-1}+ Pelletized Biochar	24,112.50
T_5 – Pelletized Biochar	11,787.50

Table 15. Cost and return analysis of one-hectare watermelon as affected by pelletized biochar

Treatments	Total cost of production (Peso)	Gross income (Peso)	Net income (Peso)	ROI (%)
T_1 – 20-0-0 kg NPK ha^{-1}	60,822	388,249	327,427	538.34
T_2 – 10-0-0 kg NPK ha^{-1}	57,311	322,687	265,376	463.04
T_3 –20-0-0 kg NPK ha^{-1}+ pelletized biochar	153,049	637,999	484,950	316.86
T_4 – 10-0-0 kg NPK ha^{-1}+ pelletized biochar	142,335	361,687	219,351	154.11
T_5 – Pelletized Biochar	115,385	176,812	61,427	53.24

Computed fruit yield per hectare (kg/ha)

The computed fruit weight per hectare was significantly affected by different treatment as presented in Table 14. The plants applied with pelletized biochar at three (3) tons with 50% of inorganic fertilizer obtained the heaviest fruit per hectare with 42,533.33 kg followed by T_1, T_4, and T_2 with a mean of 25,883.33 kg, 24,112.50 kg, and 21,512.50 kg respectively. The least value obtained in T_5 with 11,787.50 kg.

Cost and return analysis

The cost and return analysis of producing one-hectare watermelon as presented in Table 15. Among the plants amended with biochar, the plants applied with pelletized biochar at three (3) tons with 50% of inorganic fertilizer obtained the highest Return of Investment with 316.86 followed by T_4 with 154.11, and the least obtained in T_5, sole pelletized biochar with 53.24.

Conclusion

Based on the results of the study, it can be concluded that the application of pelletized biochar alongside inorganic fertilizer significantly improved the chemical properties of the soil. This included an increase in soil pH and organic matter content, as well as enhanced availability of macro and micronutrients. Additionally, the use of pelletized biochar positively influenced the growth and yield performance of watermelon. Furthermore, the application of pelletized biochar proved to be economically beneficial, as it enhanced the return on investment.

Recommendations

Based on the findings of the study, the following recommendations are proposed:

1. The application of pelletized biochar in combination with inorganic fertilizer is recommended as it improves soil pH, enhances macro and micronutrient availability, and achieves a desirable fruit yield.
2. The use of pelletized biochar as an organic soil amendment, alongside inorganic fertilizer, is advised for its ability to enhance the growth and yield of watermelon.
3. The application of pelletized biochar with inorganic fertilizer is further recommended for its potential to increase the return on investment.
4. Additional studies are recommended to explore other potential benefits and optimize the use of pelletized biochar in various agricultural systems.

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