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Weighing up the agronomic characteristics of tomato applied with vermicast as soil amendment

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Key words: Agronomic, Tomato, Vermicast, Pro-active approach, Organic agriculture

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Abstract

Organic agriculture takes pro-active approach as opposed to treating problemsafter they emerged. The experiment was laid out in a 500m² area divided into five treatments with 3 blocks following the Randomized Complete Block (RCBD) design. Each block was subdivided into equal plots measuring 5m x 4m each for the treatments. The study was conducted at the Nature Farm of Cagayan State University, Piat Campus. Findings show that the tallest plants, most number of fruits, heaviest fruits, highest fruits, and highest return of investment were obtained by the plants applied with combined inorganic fertilizer and vermicast. Moreover, the soil pH has a slight decrease from 6.52 to 5.25 while organic matter (N) content of the soils has slightly increased from 0.72 – 1.03. Conclusively, application of combined 90-0-0kg N ha-1 and 10 bags of vermicast contributes significant impact on the growth and development of the test plant and improved its agronomic characteristics.

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Introduction

Tomato (*Lycopersicum esculentum L.)* locally known as *kamatis* in the Philippines, is an edible, red berry-type fruit of the nightshade *Solanum lycopersicum*. It is grown both for home consumption and for commercial trade. Tomato is one of the world's major vegetable with a worldwide production of 182.3 million of tonnes in the year 2017 FAOSTAT, (2019). It can be eaten raw, ingredient in many dishes, sauces, drinks, and mostly in salads. Sometimes, it is also considered as culinary vegetable. Essentially, tomato has multiple nutritional facts. A cup of fresh tomato weighing 42 grams as appetizer for lunch and dinner can give 10.8 kilocalories for energy, 0.36 grams of protein, 0.12 grams of fat, 12.4 milligrams of calcium, 10.4 milligrams of phosphorus, 0.4 milligrams of iron, 152 micrograms of beta carotene, 0.02 milligrams of thiamine, 0.012 milligrams of riboflavin, 0.24 milligrams of niacin, and 13.6 milligrams of vitamin C, (FNRI, 2018).

Stated in the Tomato Production Guide of the Department of Agriculture Region 2 that most used variety of tomato in the Philippines is Diamante, a hybrid variety for year round tomato production. It is a heat tolerant variety allowing better fruit set even under hot condition, early maturing, and high level of resistance to bacterial wilt and with excellent prolificacy that results to very high yield levels. The fruits are round in shape, over 40 grams in weight, and have a very thick flesh.

Asia is the world leader in consumption with 159kg per year, while the Latin America ranks last with a per capita consumption of only 55kg per year by the agri benchmark (2014). Philippine Nutrition Facts And Fig.s (2015), reported that tomato is in the top 30 commonly consumed food items, mean intake and proportion of households consuming by wealth quintile.

Tomatoes are excellent source of nutrients to suffice body ailments and part of balanced diet (Li and Xu, 2014; Pouchieu *et al.*, 2014). Chadha *et al.* (2011) conducted research and development activities to increase access to and improve consumption of diverse and nutrient-rich vegetables, particularly in areas where malnutrition is prevalent. Tomatoes have become well-known as an important source of lycopene, which is a powerful antioxidant that acts as an anti-carcinogen and also provide vitamins and minerals. One medium ripe tomato (~145 grams) can provide up to 40 percent of the Recommended Daily Allowance of Vitamin C and 20% of Vitamin A. They also contribute B vitamins, potassium, iron and calcium to the diet. Tomato has been recently gaining attention in relation to the prevention of some human diseases. This interest is due to the presence of carotenoids and particularly lycopene, which is an unsaturated alkali compound that appears to be an active compound in the prevention of cancer, cardiovascular risk and in slowing down cellular aging (Gerster, 1997; Di Cesare *et al.,* 2012; abdel-Monaim, 2012 Salem) as cited by M. Al-Amri, (2013).

Fertilizer is indispensable in crop production since it is needed by crop to complete their life cycle. Zhang, S. *et al.* (2016) stated that soil organic material is the major nutrient elements for plant. Fertilizer plays a very important role in improving soil aggregation soil aeration, stable soil temperature and better water holding capacity. The use of organic fertilizers is increasingly becoming popular among vegetable growers in Region 02. In a survey conducted by Padilla *et al.* (2017), they reported approximately 53% of the respondents used organic fertilizer at leastonce in their farming operations. Tomato can be grown in the backyard and in commercial scale for community consumption and for industrial use (product processing), respectively. With the many uses and great potentials of tomatoes, there is a pressing need to improve its productivity without compromising the quality of produce. Catedral (2019), underscored the importance of good field planning in achieving a successful vegetable farming venture. He also discussed that food security start at home and he encouraged to practice organic farming in the backyards. Organic farming is a method of farming that involves the use of ecologically friendly techniques for producing crops.

Given all factors of crop production at their optimum, healthy soil is the key to successful organic crop

production. Plants require good quality soil with enough amountsof essential nutrients to grow well and produce more yields. There are many different ways (mitigation) to feed the soil for it to supply nutritional requirements of plants to ensure better production or yield, such as the application of organic fertilizer or any soil ameliorants. Organic fertilizers increase the yield and quality of agricultural crops in ways similar to inorganic fertilizers (Heeb *et al.,* 2006; Liu *et al.*, 2007). They take the place of inorganic fertilizers in sustainable agriculture system.

The main sources of the organic fertilizers are decomposed livestock manures, plant residues, and organic-based concoctions like Fish Amino Acidm (FAA), Indigenous Microorganisms (IMO) etc., and processed industrial wastes. Organic-based fertilizers can provide nutritional requirements of plants as they increase the microbial activity in soil, anionand cation exchange capacity, organic matter and carbon-content of soil. The Asia Regional Organic Standard (AROS) stated that, intervention and inputs that are being mandated aretowards using Organic agriculture (OA), which regulate and mandate the use of organic fertilizer for crop production. OA farming aims to employ long-term ecological, system- based organic management, assuring long-term, biologically-based soil fertility. It considers the medium and long term effect of agricultural inventories on the agro-ecosystems. Organic agriculture takes pro-active approach as opposed to treating problems after they emerged. The impact of organic agricultural system on natural resources favours interactions with the agro-eco system that is vital for both agricultural and nature conservation.

Objective of the Study

The general objective of the study is to evaluate the agronomic characteristic and yield performance of Tomato (*Lycopersicum esculentum* L.) using vermicast as soil amendment under CSU-Piat condition.

Specifically, the study aimed to

Determine the agronomic characteristics of tomato applied with vermicast assoil amendment;

Materials and methods

Research Design

The experiment was laid out in a 500m² area divided into five treatments with 3 blocks following the Randomized Complete Block (RCBD) design. Each block was subdivided into equal plots measuring 5m x 4m each for the treatments. The study was conducted at the Nature Farm of Cagayan State University, Piat Campus from February 6, 2019 to June24 2020 with an alleyways of one (1) meter between blocks and 0.5 meter between plots were provided. The treatments are as follows:

Treatment	Description	Rate per Plot
Treatment 1	Control	(Recommended Rate) RR
Treatment 2	Full Vermicast	2.5kg/plot or 10 bags/ha
Treatment 3	½ RR + Vermicast	0.5kg/plot + 2.5kg/plot
Treatment 4	¾ RR + Vermicast	0.75kg/plot + 2.5kg/plot
Treatment 5	FULL RR + Vermicast	1kg/plot + 2.5kg/plot

Materials

The following materials were used in the study: tomato seeds variety diamante, organic fertilizer (Vermicast), soil, measuring device, weighing scale, bamboo sticks, placards, sprayer, straw lace, blender, and record notebook.

Soil Analysis

Soil samples were randomly collected from the experimental area with the use of shovel. Samples were collected at 10 strategic sites at a depth of 15cm. Collected soil samples were air dried, pulverized, mixed thoroughly and then a composite sample of approximately one (1)kg was submitted to the Cagayan Valley Integrated Agricultural Laboratory (*CVIAL*) at Carig, Tuguegarao City, Cagayan for analysis. The result was used as basis for the fertilizer treatment formulation of the study.

Data Analysis

The data obtained from this experiment were subjected to the Statistical Tools for Agriculture Research (STAR) and Microsoft excel using the analysis of variance (ANOVA) with 5% and 1% level of significance. This means that making the correct

decision in the analysis is 95% and 99% whether there is a significant difference or no significant difference between treatments.

Results and discussion

Number of Days to 50% Flowering

The flower of the crops is an indicator of growth of plants thus number of percentage of flowering encourages more production. The plants started to bear flowers at 35 days after transplanting and achieved fifty percent flowering at 55 days after transplanting. However no significant difference was observed among treatments tested based on the analysis of variance on the number of days to 50% flowering (Appendix D.).

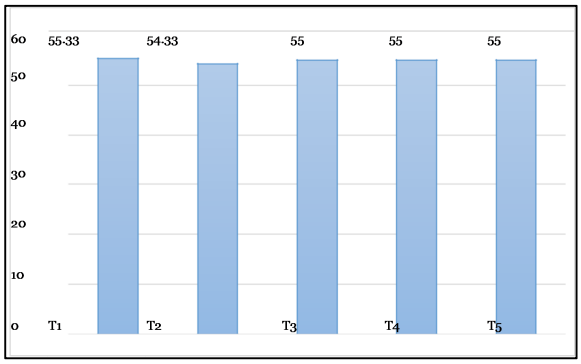

Fig. 2. Number of Days to 50% Fowering.

Plant Height at 7, 30 and 60 Days after Transplanting

Table 1 shows the result of plant height observed at 7, 30 and 60 days, as gleaned in the table at 7 DAT, T2 and T3 obtained highest plant height with an mean of 24.73cm and 24.37cm, this was followed by T5, T4, and T1 with a means result of 22.77cm, 21.70cm, and 20.97cm respectively, analysis of variance shows no significant differences among the treatments after 7DAT. At 30 DAT, plants applied with 90-0-0kg N ha^{-1} + 10 bags Vermicompost ha^{-1} (T5), 68-0-0kg N ha^{-1} + 10 bags Vermicompost ha^{-1} (T4) and 45-0-0kg N ha^{-1} + 10 bags Vermicompost ha^{-1} (T3), 10 bags Vermicast ha^{-1} (T2) obtained the tallest plants height with mean values of 50.01cm, 49.90cm 48.8cm, and 47.25cm respectively shortest plant height was obtained to 90-0-0kg N ha^{-1} (T1) with a mean of 44.66 centimeters.

Comparison among treatments mean there were significant differences among the treatments applied in tomato, as shown in the table, T3, T4, and T5 are comparable to each other but significantly difference with treatment 1. This means that application of vermicast in combination of inorganic fertilizer boost growth of tomato under CSU Piat condition.

On the 60 DAT, Treatment 5 (90-0-0kg N ha^{-1} + 10 bags Vermicompost ha^{-1}) obtained the highest plant height with a mean of 97.96cm, followed by 68-0-0kg N ha^{-1} +10 bags Vermicompost ha^{-1} (T4), 90-0-0kg N ha^{-1} (T1) and 45-0-0kg N ha^{-1} + 10 bags Vermicompost ha^{-1} (T3) with a mean averages of 97.74cm, 90.30cm, and 90.17 respectively. 10 bags Vermicast ha^{-1} (T2) garnered the lowest mean in term of plant heightat 60 DAT.

Based on the study it was observed that the application of (90-0-0kg N ha^{-1} + 10 bags Vermicompost ha^{-1}) or Treatment 5, contributes significant result in terms of height of the test plants from 7, 30, and 60 DAT. The above results were in support to the findings of Rakesh and Adarsh (2010) that addition of vermicompost to inorganic fertilizer has significant effect on the growth, fruit and yield of tomato. The organic fertilizers provide the nutritional requirements of plants and also suppress the plant pests' populations. Additionally, they increase the microbial activity in soil, anion and cation exchange capacity, organic matter and carbon-content of soil. Organic fertilizers increase the yield and quality of agricultural crops in ways similar to inorganic fertilizers (Heeb *et al.*, 2006;Liu *et al.*, 2007).

Table 1. Plant Height at 7, 30 and 60 Days After Transplanting Applied with Vermicast as Soil Amendment under CSU-Piat Condition.

Treatments	Plant Height (cm)		
	7 DAT	30 DAT	60 DAT
T_1– 90-0-0kg N ha^{-1}	20.97	44.66^{b}	90.30^{b}
T_2– 10 bags Vermicast	24.73	47.25^{ab}	80.87^{c}
T_3– 45-0-0kg N ha^{-1} + 10 bags Vermicast ha^{-1}	24.37	48.81^{a}	90.17^{b}
T_4– 68-0-0kg N ha^{-1} + 10 bags Vermicast ha^{-1}	21.70	49.90^{a}	97.74^{a}
T_5– 90-0-0kg N ha^{-1} + 10 bags Vermicast	22.77	50.01^{a}	97.96^{a}

*Means with the same letter are not significantly different.

The approximate Nutrient Analysis of Tomato

Tomatoes have an excellent source of nutrients to suffice body ailments and part ofbalanced diet (Li and Xu, 2014; Pouchieu *et al.*, 2014). This study, chemical composition of fruit samples were analyzed which includes the crude protein, crude fiber, crude fats, moisture and ash (Table 2) as affected by vermicast as soil amendments in combination toInorganic fertilizer under CSU-Piat condition, data obtained that T1 – 90-0-0kg N ha-1 garnered the highest percentage of the physico-chemical characteristics of the fruit in termsof Crude protein (4.15%), Crude Fiber (2.94%), Crude Fat (0.67), and Ash (1.85%) except on the Moisture content with a percentage of 3.55%. These results is accordance to Gonzales *et al.* 2011, that tomato peel has higher amounts of protein, lipid and lower content of ash when nutritional requirements are present or introduced well in the soil. It is clearly stated in the table that the nutritive values of tomato is differ from the different application of treatments. On the other hand as gleaned in the table, 45-0-0kg N ha-1 + 10 bags Vermicast (T3), obtained the lowest percentage on the physico-chemical analyses of the fruit in terms of Crude protein (1.21%), Crude Fat (0.20%), Moisture (3.20% and Ash(0.70%) except on the Crude Fiber with a percentage of 1.49%.

Table 2. Nutrient Analysis of Tomato as Affected by Vermicast as Soil Amendments.

Treatments	Crude Protein %	Fiber %	Fat %	Moisture %	Ash %
T1–90-0-0kg N ha-1	4.15	2.94	0.67	3.55	1.85
T2–10 bags Vermicast ha-1	1.73	1.29	0.27	4.05	0.74
T3–45-0-0kg N ha-1 + 10 bags Vermicast	1.21	1.49	0.20	3.20	0.70
T4–68-0-0kg N ha-1 + 10 bags Vermicast	1.21	1.5	0.21	4.25	0.76
T5–90-0-0kg N ha-1 + 10 bags Vermicast	1.56	1.13	0.28	5.00	0.79

Study observed that decreasing amount of the recommended rate of application decreases the physio chemical quality of the test plant. Moreover, rainfall and water supply during the maturation stage of tomato is a limiting factor for fruits. The moisture content was observed in the application of, 90-0-0kg N ha-1 + 10 bags Vermicast (T5), 68-0-0kg N ha-1 + 10 bags Vermicast (T4), and 10 bags Vermicast ha-1 with a means average of 5.00%, 4.25% and 4.05%. This indicates that the vermicasts is a good factor for retention or water holding capacity which is beneficial needs of the crops, Karthikeyan *et al.* (2014).

Number of Fruits/Plant

Fig. 4 shows the number of fruits/plants as affected by the application of vermicast as soil amendments. Results revealed that T5 (90-0-0kg N ha-1 + 10 bags Vermicast ha-1) produced the most number of fruits per hill with a mean of 27.0, closely followed by T4 (68-0-0kg N ha-1 + 10 bags Vermicast ha-1), T3 (45-0-0kg N ha-1 + 10 bags Vermicast ha-1), T1 (90-0-0kg N ha-1) and T2 (10 bags Vermicast ha-1) with a mean of 23, 20, 18 and 12, in the same order.

Analysis of variance revealed highly significant difference among treatments. On comparison among means, when T5 compared to T4 no significant difference exist but when T5 was compared to T3, T2 and T1 significant difference was observed. Such variation was attributed to the combined effects of inorganic fertilizer and vermicompost as cited by Atiyeh *et al.* (2002) that vermicompost promotes growth due to plant hormone- like activity related to microflora associated with vermicomposting and to metabolites produced as a consequence of secondary metabolism. Organic sources offer more balanced nutrition to the plants, especially micro nutrients which positively affect number of fruits in plants (Miller, 2009).

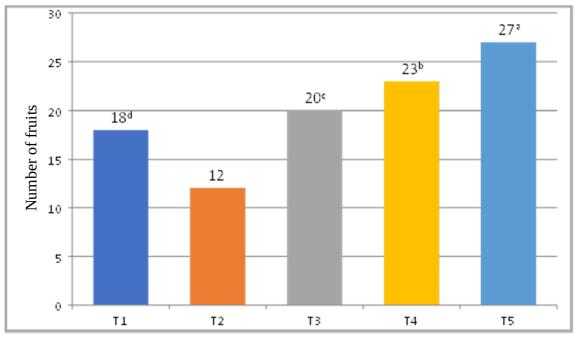

Fig.4. Number of Fruits as Affected by the Application of Vermicast as Soil Amendments.

Weight of Fruits/Plant

The weight of fruits per plant as affected by the application of vermicast as amendments was reflected

in Fig. 5. Significant result was observed on the weight of fruits per plant wherein the application of 90-0-0kg N ha^{-1} + 10bags vermicast ha^{-1} (T5) obtained the heaviest fruits with 1050 grams. It was followed by 68-0-0kg N ha^{-1} + 10 bags vermicast ha-^{1} (T4) and 45 -0-0kg N ha^{-1} (T3) with 734 and 587 grams. The lightest was obtained by pure vermicompost (T2) and Control (T1) with 261.67and 188.33 grams.

This implies that crops are given better nutrition which might increase the weight of fruits of tomato. This means that VC is reported to have hormone-like activity and this has been hypothesized to result in greater root initiation, increased root biomass, enhanced plant growth and development, and altered morphology of plants grown in VC emended soil (Muscolo *et al.*, 2009). Using phytohormone bioassays, compounds with gibberellin, cytokinin and auxin-like activity have been detected in vermicompost urban and sewage waste (Canellas *et al.*, 2002).

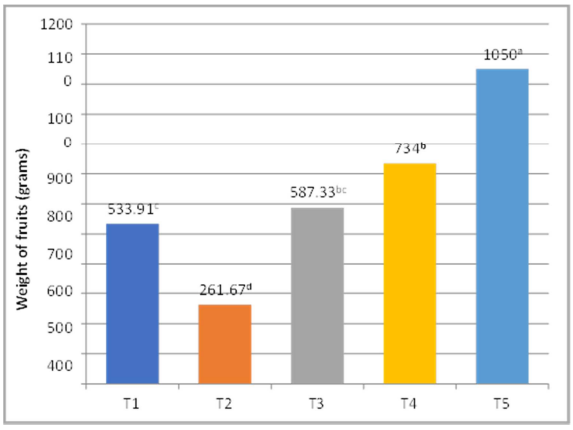

Fig. 5. Weight of Fruits (grams) as Affected by the Application of Vermicast as SoilAmendment.

Computed Yield (tons/ha)

Table 3 shows the computed yield (tons/ha) as affected by the application of vermicast as soil amendments. Result further shows T5 (90-0-0kg N ha-1 + 10 bags Vermicast ha-^{1}) produced the highest yield of 4.58 tons ha-^{1} followed by T4 (68-0-0kg Nha-^{1} + 10 bags Vermicast ha-^{1}), T1 (90-0-0kg N ha-^{1}), T3 (45-0-0kg N ha^{-1} + 10 bags Vermicast ha^{-1}), with a mean yield of 3.74 tons ha^{-1}, 3.71 tons ha^{-1}., and 3.09 tons ha^{-1}. T2 (10 bags Vermicast ha^{-1}) had the lowest yield of 1.63 tons ha^{-1}.

Statistical analysis reveals highly significant difference among treatments tested. In the comparison among treatment means, results revealed that when T1 compared with the different treatments significant difference was observed.

This means that applying vermicast in tomato obtained positive impact on the yield of tomato. This result is in conformity with the study of Satyanarayana *et al.* (2002) foundsignificant increase in rice yield due to the application of inorganic fertilizers. Combined application of different doses of vermicast and inorganic fertilizer has significant effect on grain yield of rice. The yield advantages due to integration of organic sources and inorganic fertilizers over chemical fertilizers alone might be due to the availability of nutrients for a shorter period as mineralization of nitrogen is more rapid and in turn the losses of inorganic nitrogen due to volatilization, denitrification and leaching etc., would be more. Sarwar *et al.* (2008); Ali *et al.* (2012) also claimed increased yields of rice with the use of vermicastor in combination with chemical fertilizers.

Table 3. Computed Yield (tons/ha) as Affected by the Application of Vermicast as SoilAmendment.

Treatment	Mean
T1- 90-0-0kg N ha-1	3.71 b
T2- 10 bags vermicast/ha	1.63 c
T3- 45-0-0kg N/ha + 2.5 bags Vermicast/ha	3.09 b
T4- 68-0-0kg N/ha + 2.5 bags Vermicast/ha	3.74 b
T5- 90-0-0kg N/ha + 2.5 bags Vermicast/ha	4.58 a

*Means with the same letter are not significantly different.

According to Uy *et al.* (2019) reported in economic point of view that farmers canuse the combination of organic fertilizer and reduced rate of inorganic fertilizers to boost the yield of rice as well as to maintain and improve soil health.

Findings

1. The tallest plants, most number of fruits, heaviest fruits, highest fruits, and highest return of investment were obtained by the plants applied with combined inorganic fertilizer and vermicast (T5).
2. The soil pH has a slight decrease from 6.52 to 5.25 while organic matter (N) content of the soils has slightly increased from 0.72 – 1.03.

3. On the available P content of the soils, there is a decrease in P from 136 – 5.8 ppm. On the other hand, the exchangeable K content in the soils has increased from 140-153 ppm which might be one of the significant contribution of applying vermicast to the soil. 31.

Conclusion

Based on the derived conclusion, the researcher recommended the following:

1. Application of combined 90-0-0kg N ha-1 and 10 bags of vermicast contributes significant impact on the growth and development of the test plant and improved its agronomic characteristics;
2. Improved quality of the physic-chemical properties of tomato in terms of crude fiber, crude protein etc;
3. Application of T5 – 90-0-0kg N ha-1 + 10 bags Vermicast ha-1 obtained the highest yield performance and shown highest return of investment.

Recommandations

Based on the generated conclusions, the researcher arrived with the following recommendations:

1. Vermicast have adequate total amount of macronutrient concentration which is highly recommended to use in tomato production.
2. The application of vermicast and 90-0-0kg N ha-1 will be enough to fertilize the tomato under CSU-Piat condition because it obtained the highest ROI with 37.95%.
3. A similar study should be conducted specifically on the highest amount of vermicast added to RR to determine the level of peak of production and income of tomato plants.

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