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Bio-Compost as a Soil Supplement to Improve Growth and Yield of Tomato (*Lycopersicum esculentum*)

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Abstract

Tomato is one of the most important fruit crops in the world which is consumed in a variety of ways. The high cost of chemical fertilizers has led to some farmers turning to alternative methods of production, such as the use of bio-fertilizers. Most organic waste may be changed into fertilizer at a low cost of production. The objectives of this study were to determine: 1) the effect of the application of bio-compost on growth, yield, and quality of tomato; 2) to determine the effects of different bio-compost applications on growth, yield and quality of tomato. The field was marked out into eight blocks. It consisted of four treatments with two replications per treatment. The bio-fertilizer was applied to plots and incorporated into the soil. This study showed that the application of bio-fertilizers made from food waste only, cow dung only, and food waste and cow dung improved plant growth, number of leaves, plant height and fruit yield. However, the differences were not statistically significant except for the number of leaves. The study also revealed that the application of bio-fertilizer lowered the number of days to flowering, fruiting, and ripening by 50% as compared to the control group. Promoting the adoption and use of bio-compost made from different waste stream hold the promise to increase tomato production.

Keywords

Bio-Fertilizer, Food Waste, Cow Dung, Tomato, Soil Supplement

1. Introduction

The agricultural sector is considered as one of the economic pillars in many developing countries [1]. Agriculture in Northern Ghana is predominantly on a smallholder basis. About 90% of farm holdings are less than two hectares in size. [2]. Smallholder farmers are dispersed, and this makes accessibility to support services expensive, and inefficient. Crop production is also dependent on seasonal rainfall, with largely rain-fed with limited mechanization and inadequate education on the use of improved technologies, such as high and stable yielding crop varieties, best agricultural practices, fertilizers, and other externalities. These, among many other things, have contributed to low levels of productivity in the agricultural sector. Numerous factors influence crop quality in food production; one of the main factors is fertilization practices. Soil fertility is a limiting factor in crop production [3]. The growth and yield of vegetable crops are also dependent upon on the quality and quantity of fertilizers used [4]. Therefore, to increase soil fertility and yield, inorganic/chemical fertilizers are often used.

The frequent high-rate application of inorganic fertilizer has been associated with environmental pollution, alteration in soil textures, and physical, structural properties of the soil. Moreover, it has been indicated that the nutritional value of the crops will also be affected negatively by the continuous use of synthetic fertilizer [5]. Inorganic fertilizers also increase the input costs of crop production [5]. The continuous use of agrochemicals, such as chemical fertilizers and pesticides, in production agriculture has shown to be detrimental to human health, such as infant methemoglobinemia [6]. There is also evidence of casual ecological imbalance [7] [8]. The use of chemical fertilizer has shown to also cause air and downstream water pollution resulting from eutrophication. Chemical fertilizers contain high amounts of phosphorus and nitrogen, which results in excess amounts of nutrients entering the soil [9]. When nitrogen and phosphorus are not fully utilized by the growing plants, they can be lost from the farm fields and negatively impact air and downstream water quality [9]. The agro-practice also negatively affects the roots of the crops, limiting their ability for nutrient uptake [10] [11]. Therefore, there is a need to replace this conventional agricultural practice by offering a safer alternative to the growth promotion of the plants, without negatively affecting the agroecosystem. The effort to reduce the dependence on chemical fertilizers has been made through the establishment of biologically-based, organic fertilizers (also known as bio-fertilizer) as an alternative [12]. Bio-fertilizers are made from soil bacteria that are beneficial to the plants. The premise is known as an Integrated Nutrients System, where certain nutrients required by the plants are provided by the activity of the below-ground microorganisms. This practice of using beneficial microbes in agriculture has started about 60 years ago [13].

The demand for organic foods across the world has increased as consumers become aware of the benefits to both their health and the environment. Furthermore, consumers often report the flavouring organic product, and surmised it may be healthier than conventional product [14].

Apart from the slower release of nutrients, the application of organic fertilizers, made from animal excreta or other agricultural wastes are often used to improve the structure and stability of the soil and in addition to enhancing the yield and quality of the crop [4] [15] [16].

Application of compost for restoration of degraded or contaminated soil has been demonstrated to be a useful technique for extensive areas suffering a moderate level of contamination of heavy metals [17]. Compost containing a high portion of humified organic matter can decrease the availability of heavy metals in soil by absorption [18]. This is due to the capacity of humic acid to retain or "bind" heavy metals and their molecular amalgamations [19].

Organic matter (OM) is converted by composting into a stable substance that can be handled, stored, transported, and applied to the land without having an adverse effect on the environment. Aerobic composting effectively destroys pathogens and weed seeds through the metabolic heat generated by the micro-organisms. Such composts have shown to suppress soil-borne plant pathogens [20].

Tomato (*Lycopersicum esculentum*) is a relatively short duration crop and gives a high yield, it is economically attractive with areas under cultivation increasing [21]. Moreover, tomatoes contribute to healthy, well-balanced diet rich in minerals, vitamins, essential amino acids, sugars and dietary fibres [22]. Tomato contains high levels of vitamin B and C, iron, and phosphorus [21]. Tomato fruits are consumed fresh in salads or cooked in sauces, soup and meat or fish dishes. They can be processed into purees, juices and ketchup. Canned and dried tomatoes are economically important processed products. The objectives of this study were 1) to determine the effect of the application of bio-compost on growth, yield, and quality of tomato, and 2) to determine the effects of different bio-compost applications on the growth, yield, and quality of tomato.

2. Materials and Methods

2.1. Raw Material and Treatment

Food waste only, Cow dung only, and Food waste and Cow dung, were composted thermophilically for one month, with a locally manufactured rotary drum bioreactor. The bioreactor was designed for 50 kg of compost mixture. The bioreactor is a steel barrel with an inner diameter of 586.0 mm, length of 914.4 mm and wall thickness of 0.9 mm. In each bioreactor, there was an opening of 50 cm. The opening was made for loading, unloading, sampling, and cleaning purposes. A rubber lining was fixed on the inner side of each opening to keep it tight and to prevent leakages. The reactor rotates horizontally around a fixed axis. The moisture of the waste was adjusted to 60%. Samples were placed in the bioreactor for the production of various bio-fertilizers.

2.2. Site Selection

The site analysis provided information essential for the proposed root zone irrigation design. Site factors considered were the soil type, field area, and topography (or changes in elevation), possible water sources (tank) and proximity to water sources, as well as quantities available for both seasonal and peak daily requirements.

2.3. Water Quality Determination

The water samples for tomato production were analysed for water quality. The parameters tested for were Electrical Conductivity (EC), pH, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Total Iron (Fe), Calcium (Ca), Magnesium (Mg), Manganese (Mn), and Bicarbonates (Bc). Analyses were carried out in the laboratory using standard procedures [23].

2.4. Compost and Soil Sample Collection and Characterization

The soil physicochemical properties in the study area were determined using standard laboratory methods conducted at the Laboratory. The soil samples were collected at various soil depths. The samples were placed in different moisture content cans and then labelled. Soil samples were tested for Moisture Content, Soil texture, Dry Bulk Density, Total Available Moisture Capacity and Evapotranspiration Rate. The nutrient content and other compost properties related to plant and soil factors prior to the experimentation was analyzed. Compost was analyzed for physical and chemical properties, including bulk density, dry matter content (DM), organic matter content (OM), pH, electrical conductivity (EC), total carbon (C).

2.5. Experimental Design

The field was marked out into four blocks. The Randomized Complete Block Design (RCBD) method was used. It consisted of four treatments with two replications per treatment. Each plot measured 2.5 m wide by 3.0 m long (7.5 m^2), with footpaths of 50 cm within blocks, and 1 m apart between blocks with a total land area of 7.5 m by 8 m which is equal to 60 m^2/ha. A planting spacing of 75 cm between rows and 50 cm within rows was adopted giving a plant population of 560 for the experiment.

2.6. Methods of Sampling and Analysis

Combined food waste only, cow dung only, food waste and cow dung, bio-compost analysis were required to estimate the nutrient content and other bio-compost properties related to plant and soil factors prior to the experimentation. The three compost types were analyzed for physical, and chemical properties, including bulk density, dry matter content (DM), organic matter content (OM), pH, electrical conductivity (EC), total carbon (C) and nitrogen (N) content, C: N ratio, available/soluble nutrients (mineral K, P, N and Na), and heavy metals content.

2.7. Compost and Soil Sample Collection

Eight (8) soil samples were randomly taken per plot before raising the beds. The samples were taken from the four treatments replicated to determine the fertility content of the soil and to analyse the pH, % C, % N, Available P(mg/kg), C mol/kg K. It was also used to determine the particle size distribution of % Sand, % Silt, % Clay and Texture (SCL). The bio-compost; cow dung and food waste, food waste only, and cow dung only samples were taken to determine their nutrient value of % N, % P, % K, and % C. The soil samples were composited, then primary samples were air-dried and passed through two millimeters sieve and analyzed at the Soil laboratory. The results of the physicochemical properties analysis of the soil sampled from the study area as presented in Table 1.

2.8. Water Quality Determination and Irrigation

The parameters tested for were electrical conductivity (EC), pH, total suspended solids (TSS), total dissolved solids (TDS), total iron (Fe), calcium (Ca), magnesium (Mg), manganese (Mn), and bicarbonates (Bc). Water analysis was carried out in the laboratory using standard procedures [23]. The soil physicochemical properties in the study area were also determined using standard laboratory methods. Water supply for crop production is very important especially during the dry period of production. The most critical period in crop production for water requirement is during flowering and fruit initiation, whereby at flowering and fruiting stage, the adequate soil moisture content is needed to avoid flower abortion and bloom end rot. Therefore, twice daily watering of plots was conducted for the first four weeks then followed by daily sprinkler irrigation of the plots for the remaining period in the production cycle.

Table 1. Soil physiochemical properties.

	Parameter	0 - 10 cm	10 - 20 cm	20 - 30 cm
Physical Properties	% Sand	84.00	90.00	86.00
	% Silt	12.00	6.00	10.00
	% Clay	4.00	4.00	4.00
	Texture	Loamy Sand	Sand	Loamy Sand
	B.D (g/cm^3)	1.43	1.39	1.41
	%Porosity	45.14	46.60	45.64
	% O.M	11.96	3.97	4.69
Chemical Properties	pH 1:2.5	6.95	7.58	7.74
	% O.C	6.94	2.30	2.72
	% T. N	0.67	0.22	0.26
	Ca me/100g	15.34	10.65	3.20
	Mg me/100g	2.77	1.70	0.43
	K me/100g	0.28	0.02	0.01
	Na me/100g	0.35	0.01	0.19
	ppm P	358.78	287.81	187.27

2.9. Field Data Collection and Statistical Analysis

The following data were taken weekly for two months in duplicate. From the experiment: number of branches per plant by counting the entire branches per plant, number of leaves per plant by counting the entire leaves of the plant, plant height using foot ruler, stem diameter using vernier calliper. Then, we continued collecting data on days to 50% flowering, days to 50% fruiting, days to 50% ripening through physical observation of flowers, fruiting and red ripping of fruit per plot respectively. Tomato growth and yield data were subjected to a one-way analysis of variance to determine treatment differences. The analyses were performed using GenStat Discovery Edition 4.

3. Results and Discussions

3.1. Physio-Chemical Soil and Compost Properties

Results of the physicochemical properties analysis of the soil sampled from the study area are shown in **Table 1**. The soil of the field was found to be loamy sand with an apparent bulk density of 1.43 g/cm^3 at 10 cm depth of sampling, 1.39 g/cm^3 at 20 cm depth and 1.41 g/cm^3 at 30 cm depth. The core method was used to determine the dry bulk density of the collected soil samples. Research finding has indicated that average soil bulk density for a cultivated loamy sand range between 1.33 g/cm^3 to 1.35 g/cm^3) [24]. Soil porosity is the voids between soil particles and peds which allows for water movement and retention along plants and organisms activities take place. They store water or circulate air to roots, and larger pores drain excess water. The test conducted on porosity found that the soil porosity was 45.14%, 46.60%, and 45.64% at 10 cm, 20 cm, and 30 cm depth respectively. For this percent of porosity, the soil had the ability to allow for better water movement through the soil along with better aeration for better plant root development. Allan (2004) [25]; Essien & Essien, (2014) [26] argued that porosity is the total amount of pore space in the soil and the recommended porosity of soil for crop cultivation ranges from 30% and 60%. Porosity also affects the rate of movement of air and water. The soil from the study area is good for crop cultivation with an average of 45.79% porosity. Sandy-textured soil will have good porosity because the spaces between the sand grains have few finer particles of silt or clay to fill these spaces. The study found the soil with good porosity is known to have weak strength and good aggregation. There is a wide distribution of soil pores sizes, from large pores between fine aggregates (peds) that enable drainage of water and entry of air to roots, and fine pores within aggregates that provide good water storage [25] [27].

The field capacity was 15.26% at 10 cm depth, 15.35% at 30 cm depth, and 15.37% at 40 cm of root zone depth in the experimental field. The permanent wilting point (PWP) was obtained as 6.97%. Thus, root zone depth moisture distribution shows that, at lower depths, the available water was 22.50 cm/hr for the soil type at the site. The water holding capacity of the site soil was computed, with Field Capacity (FC) = 15.33%, Permanent Wilting Point (PWP) = 6.97%, therefore Available Moisture Content (AMC) for soil was 8.36%. According to USDA-NRCS (2018) [28], loamy sandy soils usually have good aeration, but cannot hold water well. So, both water and nutrients can easily leach through the soil. Clay soils retain more water and nutrients than sand, but there is little infiltration of the water and less oxygen for the plant due to smaller pore space than those of coarser textures. USDA-NRCS (2018) [28] indicated that the size of soil particles significantly affects soil traits such as holding water, nutrients, aeration and oxygen in a balance of sand, silt, clay and organic matter as the soil was found to contain this balance [27].

Composting is the natural decomposition of organic matter by microorganisms under controlled conditions; it could also be defined to be the controlled decay of organic matter in a warm mist environment by the action of bacterial, fungi and other organism [29]. The composting process was observed to be fastest in (food waste and cow dung) and sawdust, with a ratio of 1:2 due to the availability of minerals and nutrients content of cow dung which is favourable for microbial growth and activities which in turn speed up the rate of organic matter decomposition by microorganisms [29]. The sample which contained only food waste and sawdust with no animal dung experienced a long period to mature and this is due to the low microbial activities in the composting process. The addition of cow dung to composting material was observed to have an important effect on the composting process. The consistent values obtained from the set of composting indicated that the organic materials experienced similar results obtained in many other composting systems [30]. The ambient temperature played a significant role in the resulting temperature pattern of the composting. The rapid mineralization of organic carbon and nitrogen contained in food wastes in the presence of adequate aeration and moisture as required microorganisms for the decomposition of organic compounds is responsible for the temperature pattern of the composting.

This process probably would have generated a reaction whereby carbon dioxide and bacteria were released into the composting system [31]. The temperature conditioning of composting determines the duration of decomposition and maturity of compost. The temperature patterns for the compost varies somehow with the size of the waste, the ambient temperature, the moisture content, the degree of aeration and the nature of composting materials. The pH of compost in the first week of composting was considerably lower indicating the acidic nature of the organic material. The pH values were observed to significantly increase by the second week of composting, then moved to the alkalinity range of the pH scale. The alkalinity nature of compost was observed with little variation throughout the composting process to maturity. The pH values of the compost were observed to consistently increase as the composting process progressed. **Table 2** shows the demand composition of the various compost.

3.2. Evapotranspiration and Irrigation of Tomato

The study showed that the reference evapotranspiration was found to be 3.68

Table 2. Chemical analysis of compost.

Compost Type	% C	% N	% CA	% Mg	% K	% P	Cu ppm	Zn ppm	pH 1:10	eC mS/cm 1:10	% Ash
Food Waste	45.5	1.49	0.40	0.19	0.71	0.35	1.80	6.30	5.12	4.33	9.0
Cow Dung	21.0	1.19	0.56	0.39	1.26	0.29	1.80	6.98	11.73	2.73	58.0
Food Waste & Cow Dung	35.5	1.70	0.40	0.44	1.18	0.58	1.90	8.89	10.37	4.09	29.0

mm/day. The combination of two separate processes whereby water is lost from the soil surface by evaporation and from the crop by transpiration is referred to as evapotranspiration (ET) according to Divesh (2018) [32]. Jensen *et al.* (1990) [33] indicated that the evapotranspiration rate from a reference surface, not short of water, is called the reference crop evapotranspiration or reference evapotranspiration and is denoted as ETo. Irrigation water physio-chemical analysis is shown in **Table 3**.

3.3. Growth Parameters of Tomato

The experiment was conducted on using Randomized Complete Block Design (RCBD) to determine the effects of Food waste only, food waste and cow dung, cow dung only, and Control on the number of Branches, Number of Leaves, Stem Diameter, Stem Height and Number of Fruits. **Table 4** presents results obtained from the One-Way Analysis of Variance (Randomized complete block) conducted on the data arising from the experiment. From **Table 4**, it can be observed that for Food waste only, the average response on the number of Branches is 18.1 more than the grand mean of (15.4). The food waste and cow dung effects on the average number of branches (17.1) is lower than that of Food waste only (18.1) but higher than the grand mean (15.4). The application of Cow dung only also responded with an average number of Branches (16.5) lower than the averages of food waste only and food waste and cow dung but a little higher than the grand mean of 15.4. These marginal differences as a result of the various treatments' effects are further demonstrated graphically by **Figure 1**. These findings are similar to the research conducted by Gutierrez-Miceli *et al.*, 2006 [34]. They reported that the addition of vermicompost induced an increase in tomato plant heights and stem. Plants were 11.0 cm higher in the vermicompost mixtures than in unamended soils. The stems were thicker than those in control plants. However, statistically, the analysis unveils that the average responses or average treatment effects on the number of Branches as a result of the application of the various treatments of biofertilizers are not significantly different. This is because the p-value (0.068) is higher than the alpha value (0.05). Hence, with no constriction, we can conclude that the effects of various treatments on the number of Branches are not significantly different.

The various treatments effects on the average number of Leaves were also of interest to the researchers. From **Table 4**, it can be observed that for Food waste only, the average response on the number of Leaves is 85.8 more than the grand

Table 3. Irrigation water physio-chemical analysis.

Parameter	Unit Measurement	Results	Standard Specification
pH		6.4	6.5 - 8.5
Residual free chlorine		0.00	0.00
Colour	Pt. Co	5.00	0 - 15
Turbidity	FTU	1.38	5.00
Conductivity	us/cm	227.00	N/A
TDS	Ppm	104.00	1000
TSS	Ppm	37.00	N/A
Calcium (Ca)	Ppm	14.00	N/A
Magnesium (Mg)	Ppm	4.86	N/A
Bicarbonates	Ppm	31.00	N/A
Alkalinity	Ppm	49.00	N/A
Chloride (Cl)	Ppm	32.00	250
Iron (Fe)	0.0 - 3.00 ppm	0.00	0.3
Manganese	0.0 - 20.00 ppm	0.002	0.4

Table 4. One way analysis of variance (RCBD).

Treatment	Branches	Leaves	Stem Diameter	Stem Height	Number of Fruits
Food waste only	18.1	85.8	46.8	4.20	27.0
Food waste & cow dung	17.1	75.1	56.0	4.22	28.9
Cow dung only	16.1	68.6	57.5	4.11	22.9
Control	9.9	57.4	56.0	3.85	20.6
Grand mean	15.4	71.7	54.1	4.10	24.8
$p < 0.05$	0.068	0.001	0.648	0.661	0.419
CV%	41.9	8.3	34.4	16.2	43.4

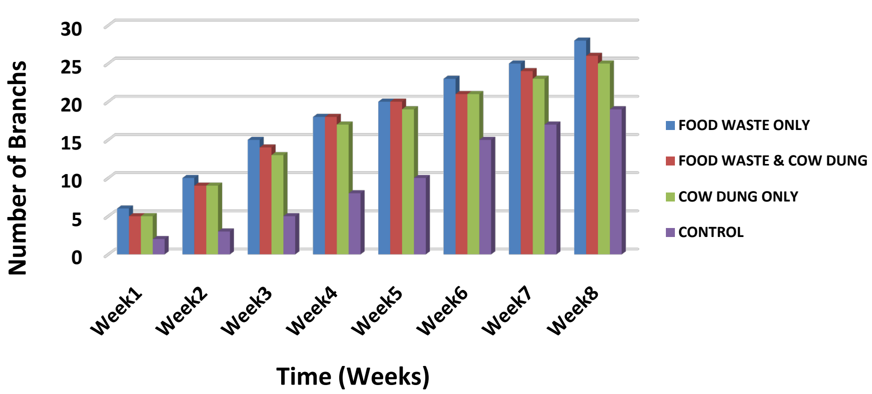

Figure 1. Number of Branches during the growth period.

mean of (71.7). The effect of the Food Waste and Cow dung, on the average number of Leaves (75.1) was lower than that of Food waste only (85.5) but higher than the grand mean (71.7). The application of Cow dung only also responded with an average number of Leaves (68.6) lower than the average responses from food waste only and food waste and cow dung and the grand mean as well. Also, the average number of Leaves as a result of the treatment control effect is 57.4 lower than all the average responses of the various treatment effects including the grand mean. Table 4 further reveals that the average responses or average treatment effects on the number of leaves as a result of the application of the various treatments (organic fertilizer) are significantly different. This is because the p-value (0.001) is lower than the alpha value (0.05). Hence, we conclude that the effects of various treatments on the average number of leaves are highly significantly different.

As a result, a pairwise comparison test was conducted using the Fisher's Protected LSD and the results indicate that the responses on the average number of Leaves upon application of the various organic fertilizers including the control are statistically significantly different when any two are paired together. The Fisher's Protected LSD further unveils that Food waste only as an organic fertilizer produces the highest average number of leaves (85.8) then followed by food waste and cow dung (75.1), cow dung only (68.6) and the least effect on the average number of leaves is Control (57.4). Figure 2, shows a weekly record of the number of leaves. It shows there is a marked difference between the various treatments. Furthermore, in Table 4, the researchers also considered the diameter of the stem and it be can be observed that for the effect of food waste only, the response on the average stem diameter is 46.8mm lower than the grand mean (54.1 mm), and all the other treatments with control inclusive.

The effect of food waste and cow dung and control presents the same response on the average stem diameter (56.0 mm) more than the grand mean and that is an appreciable increase in average stem diameter compared to a lower value of 46.8mm, an effect from food waste only. The application of cow dung only produced an average stem diameter of 57.5 mm which is marginally higher than that of food waste and cow dung (56.0 mm) and control (56.0 mm) and the grand mean (54.1 mm). However, this value of 57.5 mm is appreciable higher than that of food waste only (46.8 mm). Graphically, it can be observed in Figure 3 that there is a marginal difference in diameter representing the consequent effect of the various treatment effects. This is not inconsistent with the research conducted by Gutierrez-Miceli *et al.*, 2006 [34]. This reveals that the addition of vermicompost induced the increase in tomato plant heights and stem. Plants were 11.0 cm higher in the vermicompost mixtures than in unamended soils. The stems were thicker than those in control plants.

Notwithstanding, Table 4 indicates that statistically, there is no significant different effect as a result of the various treatment levels on the average response of stem diameter. This is because the associated p-value of stem diameter is greater than the alpha value (0.648 > 0.05). Thus, the application of Food waste

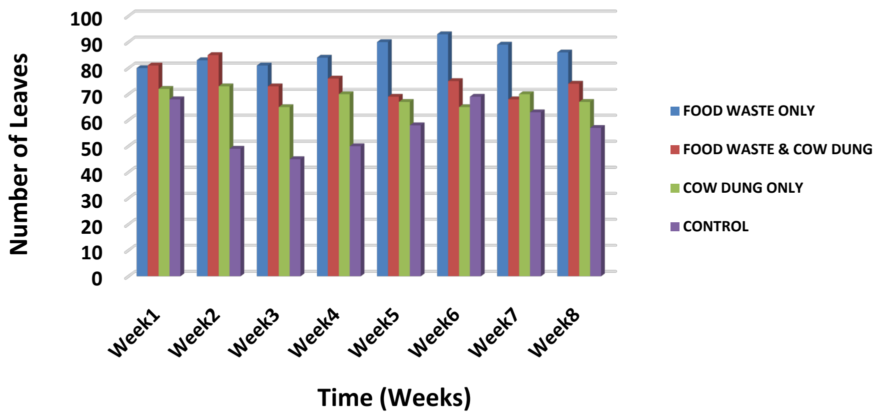

Figure 2. Number of Leaves during the growth period.

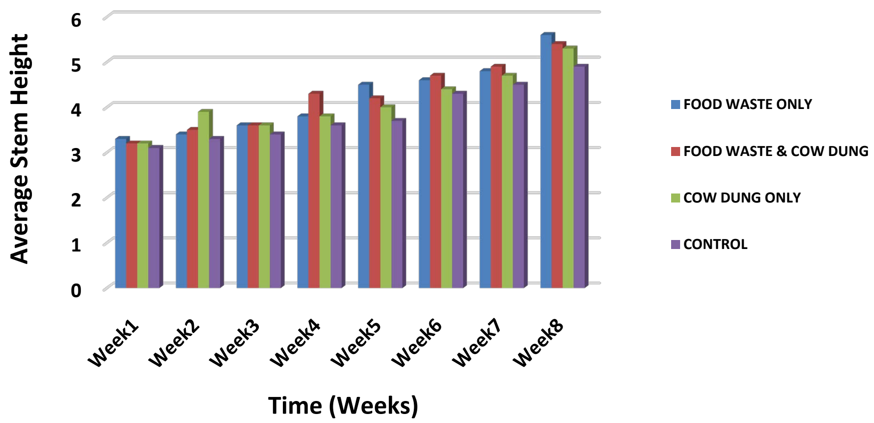

Figure 3. Average Stem Height during the growth period.

only, food waste and cow dung, cow dung only, and Control do not contribute significantly different effects on the average stem diameter.

Table 4 again presents the various treatment effect on Stem height. The application of Food waste only, food waste and cow dung, cow dung only have the following average responses viz; 4.2 m, 4.22 m, and 4.11 m on the stem height respectively. Consistent with the research conducted by Gutierrez-Miceli *et al.*, 2006 [34] which reveals that the addition of vermicompost induced an increase in tomato plant heights and stem. Plants were 11.0 cm higher in the vermicompost mixtures than in unamended soils. The stems were thicker than those in control plants. These average responses are above the grand mean (4.10) marginally but appreciable above the control effect. This is graphically demonstrated in Figure 4. However, from the Table 4, the *p*-value is greater than the alpha value (0.661 > 0.05) and hence, statistically, there is no significantly different effect on stem height upon the application of the various levels of treatments.

Finally, the researcher also sought to study the effects of food waste only, food waste and cow dung, cow dung only also on the average number of fruits produced. From Table 4, the average response on the number of fruits as a result of the application of food waste only is 27.0 more than the grand mean of 24.8,

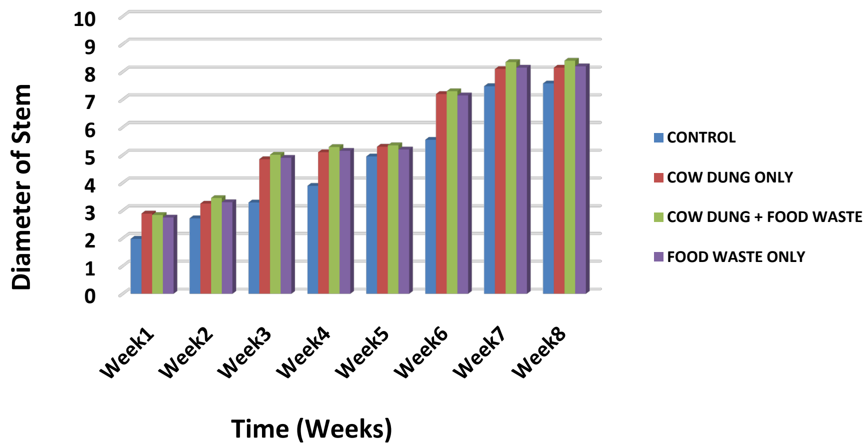

Figure 4. Diameter of Stem during the growth period.

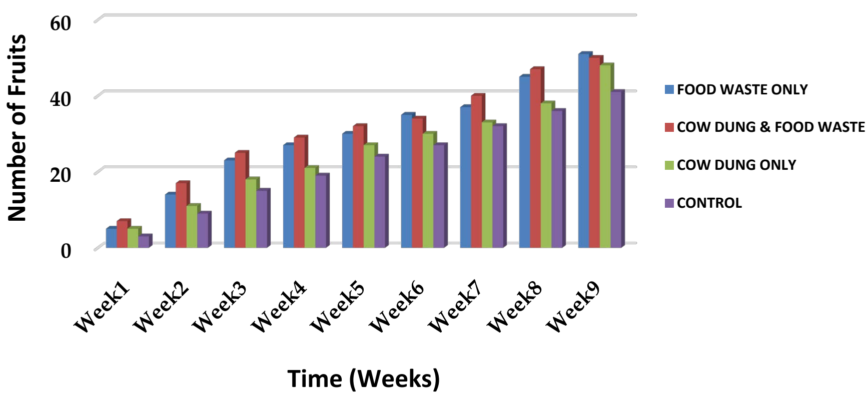

Figure 5. Number of Fruits during the growth period.

control effect of 20.6, and cow dung only (22.9). It is, however, less than the effect of food waste and cow dung on the average number of fruits whose effect on the average response on the number of fruits is 28.9. It can be observed also that only food waste and cow dung and food waste only present a marginal effect as seen on the increased average number of fruits. The increase in the average number of fruits is graphically described in **Figure 5**. However, the Table indicates that the *p*-value is greater than the alpha value (0.419 > 0.05) and hence, statistically, there is no significantly different effect on the average number of fruits produced upon the application of the various treatments. Thus, there is no significantly different effect as a result of the various treatment on the average number of fruits produced. Gad *et al.*, (2007) [35] reported that Farmyard manure significantly increased both fresh and dry weights of tomato shoots and roots. Moez *et al.* (2001) [36] found that chicken manure increased plant growth of pepper fresh and dry weights in vegetative and yield stages compared with control by 19% and 27.3% respectively (Mehdizadeh, *et al.*, 2013) [37]. Previous research showed significantly higher organic carbon, total N, P and K contents validate the statement that organic wastes-based fertilizers enhance soil fertility, either directly, because they supply nutrients, or indirectly by furnishing substrates that are mineralized by soil microflora [36]. Organic carbon added to soil with sewage sludge compost was also reported to improve bulk density, porosity, water holding capacity, and activity of aerobic bacteria [38]. Washa (2020) [39] reported that generally, there are triple advantages of using Cow manure which are: improvement of soil nutrient availability, improvement of soil microbial which has a multiple number of uses in the soil and finally improvement of soil fertility. Curci *et al.*, 2020 [38] reported the addition of low doses of composted wastes improved soil pH and electrical conductivity (EC) of the soil.

4. Conclusion

This study showed that the application of bio-fertilizers made from food waste only, cow dung only, and food waste and cow dung improved plant growth, number of leaves, plant height and fruit yield. However, the differences were not statistically significant except for the number of leaves. The study also revealed that the application of bio-fertilizer lowered the number of days to flowering, fruiting, and ripening by 50% as compared to the control group. Promoting the adoption and use of bio-compost made from different waste stream hold the promise to increase tomato production in Northern Ghana. It also showed the effect of treatment on firmness and sweetness on the tomato fruit was sampled and evaluated for its appearance, firmness and sweetness and overall quality through testing. The treatment of cow dung and food waste bio-compost showed the best results on firmness and sweetness compared to the other treatment.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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