PERFORMANCE OF TOMATO (*Solanumlycopersicum*L.)AS INFLUENCED BY ORGANIC MANURE TEA AND INORGANIC FERTILIZATION IN THE SUDAN SAVANNA, NIGERIA

BY
MUSA IBRAHIM SHEHU
(SPS/14/MAG/00006)
B. Agriculture (Crop Science)

BEING A DISSERTATION SUBMITTED TO THE DEPARTMENT OF AGRONOMY, BAYERO UNIVERSITY, KANO IN PARTIAL FULFILMENT OF THE REQUIREMENTSFOR THE AWARD OF MASTER OF SCIENCE DEGREE IN AGRONOMY

DECEMBER, 2019

DECLARATION

I hereby declare that this work is a product of my own research efforts undertaken under the supervision of Prof. M. A. Hussaini and has not been presented anywhere for the award of a degree certificate. All sources have been duly acknowledged.

____________________________ ________________

MUSA IBRAHIM SHEHU Date

(SPS/14/MAG/00006)

CERTIFICATION

This is to certify that the research work of this dissertation and the subsequent write-up for this dissertation by MUSA IBRAHIM SHEHU (SPS/14/MAG/00006) were carried out under my supervision.

____________________________ ______________

Prof. M. A. Hussaini Date

Supervisor

____________________________ ______________

Prof. S. U. Yahaya Date

Head of Department

APPROVAL PAGE

ACKNOWLEDGEMENTS

I thank Allah almighty for sparing my life and giving me the opportunity to complete this work.

I will also like to appreciate the contributions of my supervisor Prof. M. A. Hussaini and my internal examiner Prof. B. M. Auwalu for their guidance and support.

Moreover, I will like to acknowledge the contributions of the Head of Department, Department of Agronomy, BUK Prof. S. U. Yahaya, the PG Coordinator Dr. S. Rufa'i and the entire academic and non-academic staff of the Department in the success of my academic journey so far.

I would also like to acknowledge the contribution of the Federal Ministry of Agriculture and Rural Development, especially the State Coordinator Kano, Adamu Muhammad Shehu for their support throughout my studies.

DEDICATION

I dedicate this Msc. Dissertation to my parents Late Alh. Ibrahim ShehuKwatalo and HajiyaHadizaHussaini, my wife Aisha Ismail and my son Ibrahim Musa.

TABLE OF CONTENTS

Contents Pages

List of Tables

List of Figures

Appendix

ABSTRACT

Organic manure tea is of great interest to sustainable agriculture for improved access to cheap and balanced source of plant nutrients with less negative impact on the soil and soil ecosystem. The study was conducted to evaluate the effect of Organic Manure Tea on the growth and yield of Tomato under field condition. Treatments consisted of plant, compost and poultry litter tea at 100 ml m^{-2}, 200 ml m^{-2} and 300 ml m^{-2}, recommended rate of inorganic fertilizer and 0 kg fertilizer. The experiment was laid in a Randomized Complete Block Design with 3 replications at two locations (Department of Agronomy Research Farm, Bayero University Kano and Tafa Village, Kafin Hausa Local Government Area, Jigawa State) in the sudan savannah region of Nigeria. Data were collected on both growth and yield characters at 4, 6, 8 weeks after transplanting and at harvest, which were analysed. Findings of the study showed that among the manure teas, compost tea at 300 ml m^{-2} gave the best result on the growth and yield of the crop, producing an average yield of 11.3 and 16.0 t ha^{-1} at BUK and Tafa sites, respectively though the economic returns were better for plant tea at 300 ml m^{-2} with an average net farm income of N1,191,552 and N1,851,552 ha^{-1} at BUK and Tafa sites, respectively. The recommended rate of inorganic fertilizer was more efficient in increasing growth and yield of the crop among all the treatments applied with an average yield of 15.3 and 21.2 t ha^{-1} at BUK and Tafa sites, respectively. However, the study has given an insight into the possibility of using organic manure teas as a means of fertilization for field crops, though more researches are required to determine the optimum level of teas for the best yield possible.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND TO THE STUDY

Tomato (*Solanumlycopersicum* L.) is perhaps the most popular vegetable crop grown in Nigeria, with demand of over 2.3 million metric tonnes per year (GEMS4, 2015). Both wet and dry season cropping contribute to the national requirement, but bulk of the production is from the dry season cropping particularly under irrigation in the northern states and near perennial river banks in southern states. Total land area covered annually is over one million hectares with most of the production from the northern guinea and Sudan savannas (FMA&RD, 2012). Organic crop production is gaining increasing share of the vegetable market in both developed and developing economies due to the perception by consumers as healthier and safer for the environment. In Nigeria there is increasing effort by the government to promote the production of agricultural commodities for export, and with demand for organic vegetables at high end markets and developed economies, manure teas will greatly help in exploiting the country's potential to actively participate in those markets.

The primary goal of organic agriculture is to optimise the health and productivity of soil, plants, animals and people. The principal guidelines for organic production are to use materials and practices that enhance the ecological balance of natural systems and that integrate the parts of the farming system into an ecological process. (Shankara*et al*., 2015)

Application to agricultural land of soluble nutrients extracted from manure or compost piles could improve the timing and management of nutrient application throughout the season and increase the efficiency of nutrient recycling. Some farmers have started to use water extraction from manure or compost as liquid organic fertiliser (Gross *et al*., 2008). This technique has received attention in arid and semiarid regions of the world because fresh water resources in these regions are scarce (Hamoda and Al-Awadi, 1996). Furthermore, applying animal wastes through an irrigation system helps to encourage crop health and decreases the need for the use of pesticide for suppression of crop pests (ROU, 2007). Scheuerell and Mahaffee (2006), reported that the application of manure tea (where manure has been soaked in water and solids are filtered out in manure similar to making tea) to plants or soil helps to suppress disease-causing organisms through competition with beneficial organisms that improve the soil and foliar conditions.

Compost is a product of the transformation of raw organic materials in to biologically stable, humic substances suitable for a variety of soil and plant uses (Cooperband, 2000). The product that results from composting is a rich source of organic matter, dark and easily crumbled, with an earthy aroma. Compost is ideally characterized as being odourless with a fine texture, low moisture content and pathogen free (Keller *et al*., 2002). The process of composting has been suggested as a suitable method of decreasing pathogens as compared to raw organic matter (Moon, 1997). Pathogens and seeds of plants are destroyed when compost windrow temperatures reach above 60-70^{o}c for a minimum of 4 days (Larney*et al*., 2003).

Poultry litter refers to a mixture of manure, bedding material, waste food, broken eggs and feathers (Tiquia and Tam, 2002). The bedding material consists of wood shavings or by-products of agricultural production such as groundnut, wheat or rice hull (Williams *et al*., 1999).Liquid organic fertilizers like Poultry Manure Tea and Compost Tea have been found to contain nitrogen mainly in the inorganic form like ammonia (Price and Duddles, 1984; Gross *et al*., 2008) and can provide nutrients instantly to plants much like chemical fertilizers.

1.2 PROBLEM STATEMENT

The high cost of inorganic fertilizer coupled with the growing demand of organic foodfor local consumption and export due to economic and health benefits, calls for more effort in harnessing organic inputs in crop production especially in soil fertility management and crop nutrition. Moreover, the cumbersome nature of the use of organic fertilizers and the time taken for mineralization of nutrients to a readily plant available form makes researches in organic fertilizer extracts such as manure Teas paramount. Moreover, the long term impact of the use of inorganic fertilizers on soil productivity requires urgent attention.

1.3 JUSTIFICATION

Sustainable farming is possible only if year after year, the soil is improved and productivity increases. While any one plant species is limited by its genetics, constant use of agricultural land for production, mine out soil nutrients ultimately leaving the field devoid of microbes, plants and nutrients, unless fertilizers are added back in to the soil in plant available forms. Instead of solving the problem however, addition of high levels of strictly inorganic, soluble plant available nutrients has resulted in enormous problems as eventually the soil becomes no longer able to hold the nutrients and requires excess amounts of inorganic nutrients to optimally support plant growth, which is detrimental to the long term productivity of the soil.

Reducing the use of synthetic fertilizers and increasing on-farm nutrient recycling is crucial for a sustainable farming system, thereby building a healthy and biologically active soil and preventing pest and diseases by supporting and continually replenishing beneficial soil organisms.

1.4 OBJECTIVES OF THE STUDY

The objectives of the study were;

- To evaluate the effect of organic manure tea on the growth and yield of tomato
- To compare the performance of tomato under the influence of both organic manure tea and inorganic fertilization
- To evaluate the effect of organic manure fertilizer tea and inorganic fertilizer on the quality of tomato fruits

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 PLANT NUTRITION

Plant nutrition is a complex process involving 16 essential nutrients as well as many other chemical elements that are either beneficial or harmful to plant metabolism. Furthermore, the response of a crop such as tomato, to a particular nutrient status may vary with cultivar and exogenous factors such as cultural practices and environmental conditions. The provision of nutrients to the plant in quantities that are optimal for their subsequent utilization is a primary aim of crop fertilizer programmes and, since both yield and quality are adversely affected by any deviation from this optimum, it is essential at all times to avoid an excess or lack of nutrients. (Passam*et al*., 2007)

Meena*et al*. (2016) reported that soil microorganisms play a significant role in a number of chemical transformations of soil and thus, influence the availability of macro and micro nutrients. Use of plant growth promoting micro-organisms helps in increasing yields in addition to conventional plant protection. Martino *et al*. (2019) reported that tomato root mycorrhization improved nitrogen metabolism in plants, by increasing the nitrate reductase and glutamine synthatase enzymatic activity. Moreover, mycorrhization affects many aspects of vegetative and reproductive growth.

2.2 ORGANIC MANURE ON THE GROWTH AND YIELD OF TOMATO

Ghorbani*et al*. (2008) reported that organic fertilizers used do not give higher yields compared with chemical fertilizers. Sheep manure and chemical fertilizers led to the highest total tomato yield. Marketable yield was highest in poultry manure at 16 t/ha. Taiwo*et al*. (2008) also reported that application of organic manure had a significant effect on vine length, number of leaves/plant, number of branches, leaf area/plant, number of flowers/plant and fruit yield per plot of tomato grown during the 2013 dry season at Samaru, Zaria.

Singh *et al*. (2010) reported that intercropping of fast growing fodder variety of cowpea both for fodder and green manure on menthol mint for 35 days improved the efficiency of nitrogen fertilizer and economized about 30Kg N/ha^{-1}, improved the soil fertility and grain yield of succeeding Palmarosa crop (*Cymbopogonmartinii*). Fatimah *et al*. (2016) reported that growth parameters of tomato varieties showed that Chicken Manure had significant effect on plant height, root length, leaf area, shoot fresh and dry weight and leaves fresh and dry weight. Omari*et al.* (2016) reported that yield improvements and microbial activity enhancement were much more related to the synergy between plant materials, especially azadirachta and chicken manure addition to the soil. This reflects the input of the decomposition dynamics of the plant material and coupling effect resulting from the addition of chicken manure. Adekiya and Agbede (2016) reported that poultry manure incorporated in to the soil produced higher soil organic matter and soil leaf N, P, K, Ca, Mg, growth and yield of tomato compared with broadcast method. Ravindra*et al*. (2017) reported that chicken manures studied can be effective sources of essential nutrients like N and P, and also organic carbon. The results further showed that the levels of heavy metals in chicken manure were within acceptable limits and would not pose an environmental threat when directly applied to the soils. Phyto-toxicity observed on some chicken manure pointed to the need for further biodegradation through composting and vermi-composting to improve nutrient content and reduce the phyto-toxicity to levels that can be tolerated by the plants. Song-juan*et al.* (2018) reported that green manures changed the composition of soil dissolved organic matter in red paddy soil. The changes of dissolved organic matter properties caused by application of green manures may indicate the mechanism of green manures on soil fertility and sustainability.

2.3 INORGANIC FERTILIZER ON THE GROWTH AND YIELD OF TOMATO

Kirkby and Johnston (2008) reported that plant roots take up P as inorganic phosphate (Pi) from the soil solution and factors that influence the concentration of Pi in the soil solution and its rate of replenishment will affect yield. Thus, when P is strongly bonded to soil constituents Pi concentration may be less than required for optimal yield. The concentration of Pi in the soil solution can be increased by the addition of P as a water-soluble P fertilizer, or as water-insoluble P compound which in an acid environment of either the rhizosphere or bulk soil allows the release of Pi. Isa *et al.* (2013) reported NPK fertilizer enhances growth of two tomato varieties. Tomato growth increased as expressed by increase in plant height, crop dry weight, crop growth rate and relative growth rate. The higher response of tomato to the growth maybe be due to the availability of essential elements in inorganic fertilizer.

2.4 INTERACTION OF ORGANIC AND INORGANIC FERTILIZER ON THE GROWTH AND YIELD OF TOMATO

Hernandez *et al*. (2014) reported that organic fertilization improves efficiency of inorganic fertilizer so that the use of inorganic fertilizer can be reduced while still obtaining similar tomato yield and quality. Brunetti*et al.* (2019) reported that the combined application of amendments and inorganic fertilizer results in an increase of the yield of tomato in comparison to a complete inorganic fertilization, when almost the same amount of N is applied. The slower release of organic N and the synergistic effects of the inorganic fertilizer and compost could be the reason for the result obtained. In addition, the organoleptic quality of the production is apparently not affected by fertilization.

2.5 MANURE TEA ON THE GROWTH AND YIELD OF TOMATO

Martin and Nathan (1984) reported that in three month growing period, manure tea could perform nearly well in production of tomato plants as chemical fertilizer in green house. Pant *et al.* (2012) reported that compost quality impacted: nutrient extraction efficiency, microbial activity, phyto-hormones and total nutrient content of the extract. These differences in extract quality in turn influence growth and tissue mineral nutrient of Pak Choi (*Brassica rapa*). Hassan *et al*. (2013) reported that the highest fruit yield (4.67 t/ha) was obtained in Compost Tea as foliar spray and Bavistin foliar spray followed by compost soil application while the lowest yield (2.2 t/ha) was obtained in poultry litter extract as soil drenching which is statistically similar to control (2.6 t/ha). Rashidul Islam *et al*. (2013) reported that foliar application of Compost Tea may be used as an alternative environment friendly means of plant disease control to increase crop growth and yield with maximum profit. Jigme*et al.* (2015) reported that treatment with Compost Manure Tea at 200 ml week^{-2} showed the best result in terms of yield, head compactness coefficient and vegetative growth characteristics among the organic treatments used on Brocolli (*Brassica oleracea*), though it was not as effective as mineral fertilizer treatment for some growth variables. The positive dose-response pattern of CMT application suggests that there is good potential to further optimize the soil amendment. Pane *et al*. (2016) reported that compost teas were indicated to protect plants and enhance their productivity due to intrinsic molecular characteristics. Microbial composition was consistent with compost tea's potential of controlling plant diseases. Molecular profiles of dissolved organic materials induced to hypothesize the involvement of compost teas bioactive lignin-derived molecules in direct stimulation of plant responses. Min *et al.*(2015), reported that microbial communities of all aerated compost teas were predominantly bacteria. The average population densities of culturable bacteria increased in all aerated Compost Tea for three days after incubation. However fungal population densities were significantly lower than those of bacteria and significantly decreased in all Compost Teas after two days incubation. In the study, all Compost Teas exceeded the threshold and showed high microbial loads. Ibrahim *et al*. (2018) reported that conjunction of compost tea as foliar spray or soil drenching with chelates forms EDTA and humic acid micronutrient solutions which increased plant height, dry weight and dry weight of seeds, oil percentage and volatile oils in black cumin. High performance in availability, uptake and accumulation of nutrients occurred. NPK percentage increased in seeds and straw of black cumin. Compost tea enhanced the effect of micronutrient on black cumin productivity and oil content beside the uptake of NPK, when applied in combination. Massimo *et al*. (2018) reported that in Pepper (*Capsicum annum L.*) the effects of aerated water extracted Compost Tea obtained from vegetable compost, applied as foliar spray on pepper plants was evaluated for two years. In the first year total production increased to 21.9% whereas in the second year, it increased by 16.3%. The increment in the yield was related to an increase of number of fruits per plant, however, the weight of a single fruit was not affected by treatment. In both years, the physiological and nutritional status of pepper plants was increased.

2.6 FRUIT QUALITY

Mantagu and Goh, (1990) reported that most indices of fruit quality did not alter as the form of applied changes. However, tomato fruit quality indices were reduced with increasing rate of all forms of N fertilizer applied, with the exception of lycopene.

Beckles (2012) reported that the amount and type of sugars stored in tomato fruit are major constituents of post harvest tomato quality, by affecting taste and overall fruit quality. Early harvest decimates fruit sugar content, it is also worthwhile investing in optimizing growth conditions i.e nitrogen, phosphorus, potassium ratios, the use of pruning in combination with soil EC to get close to the theoretical maximal at early stages of fruit development. Vinha*et al*. (2014) reported that in a nutritional perspective, the organic tomatoes analysed were healthier than those produced by conventional practices, presenting higher phyto-chemical contents and antioxidant activity. Edosa*et al*. (2014) reported that it could not be generalized that quality assessment from different tomato experimental application of N and P nutrients growing under different production condition affected most fruit quality characteristics. Higher Total Soluble Solids (TSS) and pH were recorded for furrow and drip irrigated tomato cultivated during the dry seasons. However lower average TSS and pH was recorded from tomato planted under relatively luxurious rain fed growing conditions most likely due to prevailing low temperature during ripening and at harvest. Abolusore*et al*. (2017) reported that there were no significant differences among the various manure evaluated on nutrient component of test plant (Tomato) as well as number of days to fruit rottening. However, numerical differences were observed though not peculiar and or not consistent to any of the manure under investigation. Therefore, manure type does not significantly affect the fruit quality of tomato.

2.7 EXTRACTION OF SOLUBLE NUTRIENTS FROM MANURE/COMPOST

There are a number of methods used to extract nutrients from manure or compost. These methods range in scale from those suitable on a domestic level to those suitable on a commercial level. The aim in any method is to efficiently extract the majority of nutrients from the composted or fresh material, preferably using simple equipment to maximise the cost-benefit ratio. Factors affecting the extraction of soluble nutrients from fresh or composted material are: the initial material quality, amount of material to water ratio, aeration, fermentation nutrients, brewing time and filtration materials (Ingham 2005, Scheuerell and Mahaffee 2006).

2.7.1 Anaerobic (Passive) System

The passive method involves making compost liquid by inundating the manure or compost with water and leaving it to soak (Merrill and McKeon, 1998). Diver (2002) prepared passive organic tea by immersing a burlap bag filled with compost into a bucket or tank and stirring occasionally. Usually the brew time is long, taking between 7 to 10 days. This method has been used for hundreds of years in Europe (ROU, 2007), and the resulting liquid is more a watery extract than a brewed and aerated tea. In this method aerobic microorganisms will consume oxygen from the water and after few days will create an anaerobic system. Although these techniques produce a liquid that may be suitable for land application through some irrigation systems, it contains many compounds produced during the anaerobic process, such as butyric acid (CH3CH2CH2-COOH), nitrogen in ammonium form (NH4+) and hydrogen sulphide gas (H_2S). These may harm the roots of the plants. The two most common passive techniques are soaking in water and soaking-in-bag.

Soaking in water

This is the easiest way to prepare compost liquid where organic waste, normally chopped plant material or animal manure, is added to water at an approximate 1:25 ratio (waste : water) by volume (ROU, 2007); it is then left for a short period of time to ferment. The period of fermentation depends on how long it takes the soluble nutrients to leach out and the amount of oxygen consumed by aerobic microbes (Merrill and McKeon 1998). However, this technique has been reported as unsuitable for use in irrigation systems because it contains a large amount of solid particles that may clog emitters or droppers (ROU, 2007). The concentrations of large particulates are too high for filtration to be economically feasible.

Soaking in bag

This technique produces a product that is cleaner than the prior method. The manure or compost is put into a bag made from a permeable material, usually hessian or burlap. The bag effectively acts as a crude filter: the tighter the weave, the cleaner the solution. A bag containing the manure or compost is soaked in water for one or two days to obtain a nutrient solution (Merrill and McKeon, 1998).

2.7.2 Aerobic (Bucket-Bubble Method) System

The aerobic system equipment setup and scale of production is similar to the passive system, except (a) an aquarium-size pump and air bubbler are used and (b) microbial food and catalyst mediums are added to the solution as a food source such as simple sugars, cane syrup or sugar beet for bacteria and cellulose, humic acids or other cellulose containing material for fungi for 2 – 3 days (Ingham, 2005). The purpose of the pump is to provide the microbes with oxygen and thus maintain aerobic conditions. The addition of oxygen to the organic liquid improves the quality of extracts by reducing harmful by-products such as butyric acid, nitrogen in ammonium form (NH4+) and hydrogen sulphide gas (H2S). Merrill and Mckeon (1998) found that this extract produced low nutrient concentrations and low concentration of organic acids considered harmful to plants.

2.7.3 Manure/Compost Leachate

Compost windrow leachate is the solution that leaches from the bottom of a compost pile. This leachate is generally rich in soluble nutrients, but in the early stages of composting (raw manure) it may also contain pathogens and require further bioremediation to be suitable for foliar application or spreading (Diver, 2002). Furthermore, compost leachate in the early stages is not suitable as a foliar spray due to likely increasing the salinity (ROU, 2007).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 EXPERIMENTAL SITES

The experiment was conducted at two sites; The Teaching and Research Farm Faculty of Agriculture, Bayero University, Kano (11°58.861'N, 008°31.177'E) Kano State and Tafa Village, 14km along Hadejia-Kafin Hausa Road (12°45.125'N, 10°04.547'E) Jigawa State, both in the Sudan Savannah region of Nigeria during the 2017/2018 dry season.

3.2 SOIL SAMPLING AND ANALYSIS

Soil samples were taken using an auger at the depth of 0-30cm from the fields of experiment and analysed for physical and chemical properties. The soil particle size distribution was determined using the Hydrometer method (Atterberg, 1905), pH in water was determined using a pH meter, the organic carbon was determined using the Walkey Black Method (Walkey, 1934), total nitrogen was determined using Macro Kjeldahl Method (Kjeldahl, 1883) while available phosphorus was determined using the Bray and Kurtz-I Method (Bray and Kurtz, 1945) and the exchangeable bases were determined using Ammonium Saturation Method of sample analysis (Black *et al*., 1965).

3.3 METEOROLOGICAL DATA

Data on weather elements at the experimental sites were obtained for the duration of the research period from the Department of Geography, Bayero University, Kano and Metrological Unit, BinyaminuUsman Polytechnic, Hadejia, Jigawa State.

3.4 TREATMENTS AND EXPERIMENTAL DESIGN

The treatments consisted of three manure teas (Compost, Plant and Poultry Litter) at three levels (100, 200 and 300 ml m^{-2}) and two controls (0 kg fertilizer and the recommended rate of inorganic fertilizer (125 kg N - 50 kg P_2O_5- 50 kg K_2O ha^{-1}). The treatments were laid out in a Randomized Complete Block Design with three replications. There were 33 plots at each site, with a gross plot consisting of six rows each 5 m long and 0.60 m apart. The net plot consisted of two sampling rows 5 m long each 0.64 m apart with 0.5m at both ends discarded due to border effect. The two innermost ridges were used for harvesting and yield determination.

3.5 AGRONOMIC PRACTICES

3.5.1 Sample Preparation

The compost was prepared by Passively Aerated Wind-row Method. The C/N ratio of the raw materials was maintained at 1:30 (1: N source material, 30: C source material), which consisted of manure and maize stalks/grasses for N and C sources respectively. The compost mixture was placed inside a large polythene covering a dimension of 2 m in height and 0.8 m wide. One perforated plastic pipe, having four rows of 1.27 cm diameter holes drilled in it, was inserted into the compost bag for aeration. The mouth of the bag was closed and the upper ends of the inserted pipes were exposed to the open air to facilitate aeration in the interior of the compost pile. The composting lasted for eight weeks. Fresh chicken manure was obtained from the University poultry farm unit from beneath the battery cages containing laying hens.

The compost and poultry litter tea were prepared as described by Ingham (2005), by collecting 10 kg each of compost and poultry litter weekly and then put in a jute bag, then tied with a string and placed in containers without touching the bottom. Then 20 litres each of water were added to the containers. One (1) litre of dissolved molasses was also added to the water to aid microbial activities. A lid was then put partially on the container and stirred twice daily for the first week and once a week for two more weeks.

After 21 days, the manure tea was collected and diluted in a ratio of 2:1 (2: clean water and 1: concentrated manure tea) and then used for the experiment.

Plant tea was prepared using the soft branches and leaves of cowpea, cassava and pumpkin 15 kg which were shredded in to small pieces and put in a container with a capacity greater than 200 litres. Then 5 kg of cow dung and 0.5 kg ash were then added after which water was added to reach the 200 litre mark. The mixture was stirred for 5 minutes each day for a week and then once a week for two weeks. After three weeks the plant tea was diluted at a ratio of 2:1 (2: clean water and 1: concentrated manure tea) and used for the experiment.

3.5.2 Tea Analysis

The manure teas were freshly sampled after preparation and analysed for nitrogen, phosphorus and potasium. Nitrogen was determined using Kjeldahl method, Phosphorus was determined using Bray and Kurtz-I method and potasium using Ammonium Saturation Method.

3.5.3 Treatment Application

The Teas were applied from 3 weeks after transplanting (WAT) to 8 WAT on weekly basis. The recommended rate of inorganic fertilizer (125 kg N ha^{-1} + 50 kg P_2O_5 ha^{-1}+ 50 kg K_2O ha^{-1}) was split applied using NPK 15:15:15 (to supply 50kg N, P_2O_5 and K_2O) at 3 WAT and the balance of 75 kg N ha^{-1} applied using urea at 8 WAT.

3.5.4 Variety

UC 82B tomato variety which is an open pollinated determinate variety with 70-80 days gestation period was used. It is mainly a dry season variety which is resistant to *Verticilliumdalhiae* and *Fusariumoxysporum,* and exhibits a spreading growth pattern.

3.5.5 Nursery

The seeds were sown in raised beds 120 cm wide and 25 cm high. Lines were drawn 15 cm apart on to which the seeds were thinly sown and covered gently. The seed bed was covered with straw until germination. After germination, the straw was removed. All other management practices including fertilization, weed management, pest and disease management etc, were carried out. The duration of the nursery was 6 weeks.

3.5.6 Land Preparation

The site was cleared and basins prepared according to specifications of the experiment with irrigation channels and drainage where necessary.

3.5.7 **Transplanting**

After the nursery, the vigorous seedlings at 6 weeks after sowing were transplantedon to the field on the prepared plots and spaced at a spacing of 0.45m intra row and 0.60m inter row. Each plot was tagged and labelled according to the applied treatments.

3.5.8 Irrigation

Irrigation was controlled by surface flooding allowing filling of basins individually. The crops were irrigated at 5 days interval.

3.5.9 Weeding

Hoe weeding was done at 3 and 7 WAT.

3.5.10 Harvesting

Harvesting was done when the fruits attained physiological maturity and fruit colour started changing to red.

3.6 DATA COLLECTION

3.6.1 Growth Characters

Five randomly selected plants in the sampling rows were tagged and used for data collection. Data on growth characters were collected at 4, 6, 8 WAT and at harvest. The characters studied were;

Stand count at 2 WAT and at harvest: The stand count was determined at 2 WAT and at harvest, by physically counting the plant population in each plot and the values recorded.

Plant height: This was done by measuring the tagged plants from the ground level to the end of the terminal bud, and the mean values recorded.

Number of leaves per plant: This was done by counting the number of fully developed leaves from each of the tagged plants, and the mean values recorded.

Leaf area per plant: A portable leaf area meter (YMJ-A) was used to measure the leaf area of five sampled plants in the sampling rows and the mean of the figures recorded.

Leaf area index (LAI): LAI was determined using the relation;

$$LAI = \frac{LA}{GA}$$

Where, LA= Leaf Area of the tagged plant and

GA= Ground Area Covered by the tagged plant. The means were computed and recorded

Total dry matter per plant (g): The total dry matter of five (5) representative samples was determined by cutting the sampled plants above ground level then oven dried to a constant weight at 60°C. The samples were then weighed and the values recorded at 4, 6, 8 WAT and at Harvest.

Crop growth rate (CGR) (g m^{-2} $week^{-1}$): The dry weights obtained from samples above were used to determine the CGR using the relation;

$$CGR = \frac{w2 - w1}{t2 - t1}$$

Where w_2 and w_1 are the dry matter weights at t_2 and t_1 respectively. (Watson, 1956)

Relative growth rate (g g^{-1} $week^{-1}$): The dry weights obtained from samples above were used to determine the RGR using the relation;

$$RGR = \frac{loge\, w2 - loge\, w1}{t2 - t1}$$

Where w_1 and w_2 are weights at times t_1 to t_2. (Williams, 1946)

Net assimilation rate (g g^{-1} $week^{-1}$): The dry weights obtained from samples above were used to determine the net assimilation rate using the relation;

$$NAR = \frac{1}{A} X \frac{dw}{dt}$$

Where A is the total leaf area and dw and dt indicating change in weight and time respectively. (Gregory, 1917)

Days to 50% flowering: The days taken from transplanting to when 50% of the plants in each plot flowered was counted and recorded.

Stem diameter (cm): The diameter of the five randomly selected plants was determined using a digital vernier calliper (150 mm). The diameter was measured at the base of the plant above ground level.

Leaf chlorophyll: A leaf chlorophyll meter (SPAD-502 plus) was used to measure the leaf chlorophyll of the sampled plants. Eight (8) leaves were considered per plant and the average recorded.

3.6.2 Yield Characters

The yield characters were determined as the fruit reached physiological maturity. 5 plants in the net plot that were randomly selected and tagged were used.

Number of fruits per plant: The cumulative total number of fruits harvested at maturity from the five (5) sampled plants in the net plot was counted and the means recorded.

Total number of marketable fruits per plant: The total number of wholesome fruits, free from damage by insects or rodents, without cracks or infection at harvest from the sampled plants was counted and the means recorded.

Mean fruit weight (g): The average weight per fruit from each plot was determined as follows;

$$\text{Average fruit weight} = \frac{\text{Fruit weight per net plot}}{\text{Number of fruit per net plot}}$$

Mean fruit diameter (cm): The diameter of 10 fruits per plant was determined using a digital vernier calliper, measurement was taken at the mid-section of the fruits and the mean values recorded.

Total fruit weight per plant (kg): The cumulative weight of harvested fruits from the 5 sampled plants was determined using an electronic weighing balance (MT: 2000) and the means recorded.

Total fruit yield per hectare (kg ha^{-1}): The total yield per hectare was determined from the yield of each net plot and extrapolated to hectare, using the relation;

$$\text{Yield ha}^{-1} = \frac{\text{YieldPlot}^{-1}\ (\text{kg}) \times 10{,}000\ \text{m}^{-2}}{\text{Plot Area (m}^2)}$$

Brix value: The brix value of 5 fruits from the tagged plants in the net plot was determined using a refractor meter (Ref 106/116/106 bp) and the means were recorded.

3.7 DATA ANALYSIS

The data collected were subjected to analysis of variance (ANOVA) using JMP (2018 version) statistical software package. The means were then separated using the Student-Neuman- Keuls (SNK) test.

3.8 COST BENEFIT ANALYSIS

The net farm income was used in the cost benefit analysis. It was determined using the equation below;

NFI = TR – TC

TR = Q * P

TC = TVC + TFC

Where; NFI: Net Farm Income (N)

TR: Total Revenue (N)

TC: Total Cost (N)

Q: Quantity of Produce

P: Unit Price of Produce

TVC: Total Variable Cost

TFC: Total Fixed Cost.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 RESULTS

4.1.1 Chemical Analysis of Manure Teas

The results of the chemical analysis of the manure teas are presented in Table 1, which shows that the Compost Tea contained greater amounts of total nitrogen (3.5 mg L^{-1}), total phosphorus (1.7 mg L^{-1}) and total potassium (8.3 mg L^{-1}) than poultry litter tea and plant tea.

4.1.2 Physical and Chemical Properties of Soils of Experimental Sites

The results of the physical and chemical analysis of soils of the experimental sites are presented in Table 2. It showed that the soil at BUK site was sandy loam and that of Tafa site was loamy. It also showed that the soil at BUK site was slightly more acidic (pH 5.9) than that of Tafa site (pH 6.6) but both soils were within the optimal range of soil pH for Tomato crop cultivation. The analysis also showed low organic carbon (0.82 g kg^{-1}, 1.3 g kg^{-1}), low total nitrogen (0.09 g kg^{-1}, 0.25 g kg^{-1}) and moderate available phosphorus (13.1 mg kg^{-1}, 18.4 mg kg^{-1}) for the two locations, respectively.

4.1.3 Plant Height (cm)

The response of Tomato to different levels of the treatments on plant height is presented in Table 3. At 4 WAT, the result showed significant effect on plant height with the 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} (16.4cm, 16.7cm) producing taller plants more than all the other treatments applied at BUK and Tafa, respectively except plant tea at 300 ml m^{-2} (16.2), which was statistically at par at BUK site.

Table 1.Chemical Properties of Manure Teas Used in the Experiment.

Samples	Total Nitrogen (mg L^{-1})	Total Phosphorus (mg L^{-1})	Total potassium (mg L^{-1})
Compost Tea	3.5	1.7	8.3
Poultry Litter Tea	1.5	0.5	2.9
Plant Tea	2.2	0.9	4.7

Table 2. Physical and chemical Properties of Soils of the Experimental Sites at 0-30 cm Depth During the 2017/2018 Dry Season.

Soil Characteristics	BUK	Tafa
Particle Size (g kg^{-1})		
Sand	840	440
Silt	105	310
Clay	55	250
Textural Class	Sandy loam	Loamy
Chemical Composition		
pH in water	5.9	6.6
Organic Carbon (g kg^{-1})	0.82	1.3
Total Nitrogen (g kg^{-1})	0.09	0.25
Available Phosphorus (mg^{-1} kg)	13.1	18.4
Exchangeable Bases ($cmol^{+}$ kg^{-1})		
Ca	3.6	1.9
Mg	2.5	1.6
K	0.5	0.32
Na	0.37	0.19
CEC ($cmol^{+}$ kg^{-1})	4.8	7.1

BUK=Bayero University, Kano

Table 3. Effect of Organic Manure Tea on Plant Height (cm) of Tomato at Bayero University, Kano (BUK) and TafaDuring the 2017/2018 Dry Season.

	Weeks After Transplanting (WAT)							
	4		6		8		Harvest	
Treatments	BUK	Tafa	BUK	Tafa	BUK	Tafa	BUK	Tafa
0 kg ha^{-1}	11.5^{e}	15.0^{cd}	14.5^{f}	17.6^{f}	20.1^{f}	25.4^{f}	26.8^{f}	27.2^{f}
(125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1})	16.4^{a}	16.7^{a}	28.1^{a}	30.1^{a}	39.4^{a}	40.2^{a}	49.6^{a}	51.1^{a}
Poultry Litter Tea (ml m^{-2})								
100	13.8^{cd}	14.6^{d}	7.8^{cd}	20.2^{e}	26.2^{e}	28.6^{e}	33.7^{e}	32.7^{e}
200	15.2^{b}	15.6^{c}	16.2^{d}	24.6^{cd}	27.8^{de}	29.2^{d}	34.8^{de}	34.6^{de}
300	15.8^{b}	13.0^{de}	19.4^{c}	26.2^{bc}	31.6^{bc}	32.7^{c}	41.2^{b}	38.2^{c}
Compost Tea (ml m^{-2})								
100	15.7^{b}	15.1^{bc}	18.6^{c}	23.0^{d}	28.0^{d}	32.4^{c}	37.0^{cd}	37.8^{c}
200	13.3^{d}	13.5^{de}	18.6^{c}	26.0^{bc}	29.6^{cd}	34.6^{b}	37.9^{c}	32.8^{e}
300	15.8^{b}	15.6^{bc}	22.5^{b}	27.4^{b}	32.8^{b}	35.5^{b}	42.7^{b}	39.2^{bc}
Plant Tea (ml m^{-2})								
100	14.4^{c}	16.2^{b}	16.2^{d}	20.4^{e}	29.4^{cd}	31.0^{cd}	36.2^{d}	36.8^{cd}
200	15.2^{bc}	11.1^{e}	18.4^{c}	24.2^{d}	28.8^{d}	28.4^{e}	36.4^{d}	36.4^{d}
300	16.2^{ab}	16.0^{b}	21.8^{b}	25.2^{c}	30.9^{c}	34.8^{b}	42.2^{b}	43.5^{b}
SE±	1.42	1.73	2.03	1.57	2.48	2.86	3.67	2.51

*Means followed by the same letter(s) within column are not significantly different ($P \leq 0.05$), using SNK Test.

At 6 WAT, there was also significant difference in plant height among the treatments applied, with 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} (28.1cm, 30.1cm) producing the tallest plants compared to the other treatments, while the shortest plants were due to 0 kg ha^{-1} (16.5cm, 17.6cm) at BUK and Tafa, respectively . Among the manure tea treatments used, compost tea at 300 ml m^{-2} (22.5 cm) and plant tea at 300 ml m^{-2} (21.8 cm) produced the tallest plants at BUK site, whereas at Tafa site, compost tea at 300 ml m^{-2} (27.4 cm) and poultry litter tea at 300 ml m^{-2} (26.2 cm) produced the tallest.

At 8 WAT, significant difference was also observed among the treatments. At BUK site, compost tea at 300 ml m^{-2} (32.8cm) and poultry litter tea 300 ml m^{-2} (31.6cm) produced the tallest plants among the manure tea treatments applied, while Compost Tea at 200 ml m^{-2} (34.6cm), Compost Tea at 300 ml m^{-2} (35.5cm) and Plant Tea at 300 ml m^{-2} (34.8cm) produced the tallest at Tafa site among the manure teas. However, 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} (39.4cm and 40.2cm) produced significantly taller plants compared with the manure teas at BUK and Tafa sites respectively, while the 0 kg ha^{-1} (20.1cm and 25.4cm) produced significantly shorter plants compared with the manure teas at both sites, respectively.

At harvest, the result similarly showed significantly taller plants due to 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} (49.6 cm and 51.1 cm) and the shortest plants were due to the 0 kg ha^{-1} (26.8cm and 27.2cm) at BUK and Tafa sites respectively. Among the manure teas used, compost tea at 300 ml m^{-2} (42.7cm), plant tea at 300 ml m^{-2} (43.2cm) and poultry litter tea at 300 ml m^{-2} (41.2cm) produced the taller plants at BUK , whereas compost tea at 300 ml m^{-2} (39.2cm) and plant tea at 300 ml m^{-2} (43.5cm) produced the taller plants at Tafa site.

4.1.4 Number of Leaves per Plant

The response of Tomato to different levels of the treatments on number of leaves per plant is presented in Table 4. At 4 WAT, there was significant difference among the treatments on number of leaves per plant. The highest number of leaves per plant was due to 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} (12 and 13), with 0 kg ha^{-1} (5 and 5) giving the lowest number of leaves per plant at BUK and Tafa sites respectively. Among the manure teas used, plant tea at 300 ml m^{-2} (9) produced the highest number of leaves per plant at BUK site, while compost tea at 300 ml m^{-2} (10) and plant tea at 300 ml m^{-2} (9) were the highest at Tafa.

At 6 WAT, the result also showed significant difference in number of leaves per plant with 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} (25 and 32) producing the highest number of leaves while the 0 kg ha^{-1} (9 and 11) produced the lowest number of leaves per plant at BUK and Tafa respectively. Among the manure tea treatments used, compost tea at 300 ml m^{-2} (18 and 22) showed the highest number of leaves per plant at both BUK and Tafa respectively.

At 8 WAT, application of 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} produced significantly more number of leaves per plant (41 and 50) than the other treatments applied with the 0 kg ha^{-1} produced the lowest number of leaves per plant (18 and 20) at BUK and Tafa respectively. Among the manure tea treatments used, compost tea at 300 ml m^{-2} (34) and plant tea at 300 ml m^{-2} (35) showed the highest number of leaves per plant at BUK, while compost tea at 300 ml m^{-2} (36), plant tea at 300 ml m^{-2} (35) and poultry litter tea at 300 ml m^{-2} (34) gave the highest at Tafa.

At harvest, there was similarly a significant difference in number of leaves per plant with 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} (48 and 54) producing the highest

Table 4. Effect of Organic Manure Tea on Number of Leaves per Plant of Tomato at Bayero University, Kano (BUK) and Tafa During the 2017/2018 Dry Season.

	Weeks After Transplanting (WAT)							
4	6		8		Harvest			
Treatments	BUK	Tafa	BUK	Tafa	BUK	Tafa	BUK	Tafa
0 kg ha^{-1}	5^{e}	5^{e}	9^{f}	11^{g}	18^{f}	20^{f}	20^{g}	24^{f}
(125 kg N-50 kg P_2O_5-								
50 kg K_2O ha^{-1})		2^{a}	13^{a}	25^{a}	32^{a}	41^{a}	50^{a}	48^{a}
54^{a}								
Poultry Litter Tea (ml m^{-2})								
100	6^{de}	7^{d}	12^{e}	16^{f}	23^{e}	29^{d}	32^{e}	33^{e}
200	8^{c}	7^{d}	10^{e}	17^{e}	24^{de}	28^{e}	31^{e}	35^{d}
300	7^{d}	8^{c}	14^{d}	19^{cd}	30^{c}	34^{bc}	38^{c}	38^{c}
Compost Tea (ml m^{2})								
100	7^{d}	7^{d}	12^{e}	17^{e}	23^{e}	30^{c}	34^{d}	36^{cd}
200	8^{c}	8^{c}	13^{ed}	18^{d}	25^{d}	31^{c}	28^{f}	36^{cd}
300	8^{c}	10^{b}	18^{b}	22^{b}	34^{b}	36^{b}	43^{b}	40^{b}
Plant Tea (ml m^{-2})								
100	7^{d}	7^{d}	12^{e}	17^{e}	25^{d}	32^{c}	34^{d}	35^{d}
200	7^{d}	7^{d}	13^{ed}	17^{e}	24^{de}	30^{c}	35^{d}	36^{d}
300	9^{b}	9^{bc}	16^{c}	20^{c}	35^{b}	35^{b}	39^{c}	40^{b}
SE±	0.63	0.55	0.72	0.38	0.49	0.76	0.98	0.81

*Means followed by the same letter(s) within column are not significantly different ($P \leq 0.05$), using SNK Test.

number of leaves per plant while the lowest number of leaves per plant were due to 0 kg ha^{-1} (20 and 24) at BUK and Tafa respectively. Among the manure tea treatments used, compost tea at 300 ml m^{-2} (43) produced the highest number of leaves at BUK site, whereas the highest at Tafa site were produced by compost tea at 300 ml m^{-2} (40) and plant tea at 300 ml m^{-2} (40).

4.1.5 Leaf Area per Plant (cm^2)

The response of Tomato to different levels of the treatments on leaf area per plant is presented in Table 5. At 4 WAT, the result showed significantly higher leaf area per plant due to the application of 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} (342 and 290), while the lowest was due to the 0 kg ha^{-1} (110 and 100) at BUK and Tafa respectively. Among the manure tea treatments applied, compost tea at 300 ml m^{-2} (245 and 280) produced the highest leaf area per plant at both BUK and Tafa respectively.

At 6 WAT, the result similarly showed significant difference in leaf area per plant with the application of 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} (1034 and 1280) produced higher leaf area per plant than all other treatments, while the lowest was due to 0 kg ha^{-1} (312 and 275) at BUK and Tafa respectively. Among the manure treatments, compost tea at 300 ml m^{-2} (678 and 735) produced the highest leaf area per plant at both BUK and Tafa respectively.

At 8 WAT, the result also showed significantly higher leaf area per plant due to the application of 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} (2501 and 2656) than all the other treatments applied, while the 0 kg ha^{-1} produced the lowest leaf area per plant (517 and 560) at BUK and Tafa respectively. Among the manure tea treatments applied, plant tea at 300ml m^{-2} (1485) produced the highest leaf area per plant at BUK site, whereas compost tea at 300 ml m^{-2} (1872) was the highest at Tafa site.

Table 5. Effect of Organic Manure Tea on Leaf Area per Plant (cm^2) of Tomato at Bayero University, Kano (BUK) and TafaDuring the 2017/2018 Dry Season.

	Weeks After Transplanting (WAT)							
	4		6		8		Harvest	
Treatments	BUK	Tafa	BUK	Tafa	BUK	Tafa	BUK	Tafa
0 kg ha^{-1}	110^{i}	100^{g}	312^{j}	275^{j}	517^{k}	560^{k}	601^{k}	771^{j}
(125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1})	342^{a}	290^{a}	1034^{a}	1280^{a}	2501^{a}	2656^{a}	3445^{a}	3055^{a}
Poultry Litter Tea (ml m^{-2})								
100	155^{f}	175^{f}	354^{h}	480^{i}	794^{j}	1247^{j}	1225^{j}	1683^{i}
200	147^{h}	179^{ef}	327^{i}	530^{g}	813^{h}	1260^{i}	1054^{i}	1851^{g}
300	164^{e}	190^{d}	502^{d}	646^{d}	1186^{d}	1632^{d}	1240^{f}	2166^{d}
Compost Tea (ml m^{-2})								
100	153^{fg}	183^{e}	369^{g}	544^{fg}	806^{i}	1350^{g}	1187^{g}	1908^{f}
200	182^{c}	176^{f}	354^{h}	576^{e}	894^{e}	1457^{e}	1117^{h}	1942^{e}
300	245^{b}	280^{b}	678^{b}	735^{b}	1394^{c}	1872^{b}	2155^{b}	2320^{b}
Plant Tea (ml m^{-2})								
100	151^{g}	175^{f}	464^{e}	496^{h}	882^{f}	1290^{h}	1317^{e}	1823^{h}
200	168^{d}	183^{e}	438^{f}	548^{f}	853^{g}	1380^{f}	1356^{d}	1905^{f}
300	183^{c}	247^{c}	591^{c}	701^{c}	1485^{b}	1715^{c}	1410^{c}	2226^{c}
SE±	8.52	6.24	9.14	8.33	8.67	5.28	6.04	9.07

*Means followed by the same letter(s) within column are not significantly different ($P \leq 0.05$), using SNK Test.

There was also a significant difference between the treatments on leaf area per plant at harvest. The highest leaf area per plant was as a result of 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} (3445 and 3055) and the least were due to the 0 kg ha^{-1} (601 and 771) at both sites. Among the manure tea treatments used, compost tea at 300 ml m^{-2} (2155 and 2320) produced the highest leaf area per plant at both BUK and Tafa respectively.

4.1.6 Leaf Area Index

The response of Tomato to different levels of the treatments on Leaf Area Index is presented in Table 6. At 4 WAT, the result showed significant differences between treatments on leaf area index, with the application of 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} (0.12) produced the highest LAI at BUK while the lowest was due to the 0 kg ha^{-1} (0.04 and 0.03) at BUK and Tafa respectively. Among the manure tea treatments applied, compost tea at 300 ml m^{-2} (0.09 and 0.13) produced the highest leaf area index at BUK and Tafa respectively.

At 6 WAT, application of 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} produced significantly higher leaf area index (0.38 and 0.47), while the lowest were due to 0 kg ha^{-1} (0.11 and 0.10) at BUK and Tafa respectively. Among the manure teas applied, compost tea at 300 ml m^{-2} (0.25 and 0.27) produced the highest leaf area index at both BUK and Tafa respectively.

At 8 WAT, significant differences was observed among treatments, with the application of 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} producing the highest leaf area index (0.92 and 0.98) and the lowest leaf area index was observed for 0 kg ha^{-1} (0.19 and 0.20) at BUK and Tafa respectively. Among the manure tea treatments applied, plant tea at 300 ml m^{-2} (0.55) produced the highest leaf area index at BUK, while compost tea at 300 ml m^{-2} (0.69) was the highest at Tafa.

Table 6. Effect of Organic Manure Tea on Leaf Area Index (LAI) of Tomato at Bayero University, Kano (BUK) and TafaDuring the 2017/2018 Dry Season.

	Weeks After Transplanting (WAT)							
	4		6		8		Harvest	
Treatments	BUK	Tafa	BUK	Tafa	BUK	Tafa	BUK	Tafa
0 kg ha^{-1}	0.04^{e}	0.03^{f}	0.11^{g}	0.10^{h}	0.19^{g}	0.20^{g}	0.22^{h}	0.28^{g}
(125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1})	0.12^{a}	0.10^{b}	0.38^{a}	0.47^{a}	0.92^{a}	0.98^{a}	1.27^{a}	1.13^{a}
Poultry Litter Tea (ml m^{-2})								
100	0.05^{d}	0.06^{e}	0.13^{f}	0.17^{g}	0.29^{f}	0.46^{f}	0.45^{e}	0.62^{f}
200	0.05^{d}	0.06^{e}	0.12^{fg}	0.19^{ef}	0.30^{f}	0.46^{f}	0.39^{g}	0.68^{de}
300	0.06^{cd}	0.07^{d}	0.18^{d}	0.23^{cd}	0.43^{d}	0.60^{d}	0.50^{d}	0.80^{c}
Compost Tea (ml m^{-2})								
100	0.05^{d}	0.06^{e}	0.13^{f}	0.20^{e}	0.29^{f}	0.50^{ef}	0.43^{ef}	0.70^{d}
200	0.06^{c}	0.06^{e}	0.13^{f}	0.21^{d}	0.33^{e}	0.53^{e}	0.41^{f}	0.71^{d}
300	0.09^{b}	0.13^{a}	0.25^{b}	0.27^{b}	0.51^{c}	0.69^{b}	0.79^{b}	0.85^{b}
Plant Tea (ml m^{-2})								
100	0.05^{d}	0.06^{e}	0.17^{de}	0.18^{f}	0.32^{e}	0.47^{f}	0.48^{d}	0.67^{e}
200	0.06^{cd}	0.06^{e}	0.16^{e}	0.20^{e}	0.31^{ef}	0.51^{ef}	0.50^{d}	0.70^{d}
300	0.06^{c}	0.09^{c}	0.21^{c}	0.25^{c}	0.55^{b}	0.63^{c}	0.52^{c}	0.82^{c}
SE±	0.018	0.038	0.011	0.017	0.018	0.029	0.047	0.015

*Means followed by the same letter(s) within column are not significantly different ($P \leq 0.05$), using SNK Test.

At harvest, the result also showed significantly higher leaf area index due to the application of 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} (1.27 and 1.13) more than all the other treatments applied, while the lowest leaf area index were due to the 0 kg ha^{-1} (0.22 and 0.28) at both sites. Among the manure teas used, compost tea at 300 ml m^{-2} (0.79, 0.85) produced the highest leaf area index at both BUK and Tafa respectively.

4.1.7 Stem Diameter (cm)

The response of Tomato to different levels of the treatments on stem diameter is presented in Table 7. At 4 WAT, there was a significant differences among the treatments, with the application of 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} producing the highest stem diameter (0.48cm and 0.62cm), while the 0 kg ha^{-1} (0.25cm and 0.32cm) produced the lowest at BUK and Tafa respectively. Among the manure tea treatments applied, compost tea at 300 ml m^{-2} (0.41cm), plant tea at 100 ml m^{-2} (0.38cm) 300 ml m^{-2} (0.40cm) and poultry litter tea at 300 ml m^{-2} (0.39cm) produced the highest stem diameter at BUK site, while the highest at Tafa was due to compost tea at 300 ml m^{-2} (0.57cm) and plant tea at 300 ml m^{-2} (0.54cm).

At 6 WAT, the result also showed significantly higher stem diameter due to the application of 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} (0.82cm and 0.85cm) while the lowest were due to 0 kg ha^{-1} (0.38cm and 0.42cm) at BUK and Tafa respectively. Among the manure tea treatments applied, compost tea at 300 ml m^{-2} (0.71cm) produced the highest stem diameter at BUK, while the highest at Tafa was due to compost tea at 300 ml m^{-2} (0.80cm) and plant tea at 300 ml m^{-2} (0.78cm). At 8 WAT, the result showed significantly higher stem diameter due to 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} (1.10cm and 1.28cm) while the lowest stem diameter was due to the 0 kg ha^{-1} (0.46cm and

Table 7. Effect of Organic Manure Tea on Stem Diametre (cm) of Tomato at Bayero University, Kano (BUK) and TafaDuring the 2017/2018 Dry Season.

	Weeks After Transplanting (WAT)							
	4		6		8		Harvest	
Treatments	BUK	Tafa	BUK	Tafa	BUK	Tafa	BUK	Tafa
0 kg ha^{-1}	0.25^{e}	0.32^{f}	0.38^{f}	0.42^{e}	0.46^{f}	0.66^{e}	0.69^{e}	0.72^{f}
(125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1})	0.48^{a}	0.62^{a}	0.82^{a}	0.85^{a}	1.10^{a}	1.28^{a}	1.35	1.45^{a}
Poultry Litter Tea (ml m^{-2})								
100	0.35^{c}	0.40^{d}	0.46^{e}	0.63^{d}	0.78^{e}	0.87^{d}	1.01^{d}	1.08^{e}
200	0.35^{c}	0.43^{d}	0.49^{e}	0.69^{c}	0.86^{d}	0.90^{cd}	1.06^{d}	1.15^{c}
300	0.39^{b}	0.49^{c}	0.64^{c}	0.72^{c}	0.89^{cd}	1.06^{bc}	1.13^{c}	1.22^{b}
Compost Tea (ml m^{-2})								
100	0.29^{d}	0.40^{d}	0.55^{cd}	0.63^{d}	0.85^{d}	0.87^{d}	1.01^{d}	1.13^{d}
200	0.34^{c}	0.46^{cd}	0.53^{d}	0.69^{c}	0.94^{cd}	0.93^{c}	1.07^{c}	1.19^{c}
300	0.41^{b}	0.57^{b}	0.71^{b}	0.80^{b}	1.04^{b}	1.12^{b}	1.19^{b}	1.25^{b}
Plant Tea (ml m^{-2})								
100	0.38^{bc}	0.39^{e}	0.49^{e}	0.62^{d}	0.81^{d}	0.89^{d}	0.99^{e}	1.12^{d}
200	0.25^{e}	0.50^{c}	0.51^{d}	0.67^{c}	0.79^{e}	0.97^{c}	1.05^{d}	1.17^{c}
300	0.40^{b}	0.54^{bc}	0.62^{c}	0.78^{b}	1.05^{b}	1.01^{bc}	1.12^{c}	1.27^{b}
SE±	0.082	0.034	0.051	0.088	0.032	0.041	0.045	0.039

*Means followed by the same letter(s) within column are not significantly different ($P \leq 0.05$), using SNK Test.

0.66cm) at BUK and Tafa site respectively. Among the manure tea treatments applied, compost tea at 300 ml m^{-2} (1.04cm) and plant tea at 300 ml m^{-2}(1.05cm) produced the highest stem diameter at BUK site, while the highest at Tafa was due to compost tea at 300 ml/m^2 (1.12cm), poultry litter tea at 300 ml/m^2 (1.06cm) and plant tea at 300 ml/m^2 (1.01cm).

At harvest, Application of 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} produced the highest stem diameter (1.35cm, 1.45cm) whereas the lowest stem diameter were due to 0 kg ha^{-1} (0.69cm, 0.72cm) at both sites. Among the manure tea treatments applied, compost tea at 300 ml m^{-2} (1.19cm) produced the highest stem diameter at BUK site, while at Tafa site, the highest were due to compost tea at 300 ml m^{-2} (1.25cm), plant tea at 300 ml m^{-2} (1.27cm) and poultry litter tea at 300 ml m^{-2} (1.22cm).

4.1.8 Leaf Chlorophyll

The response of the crop to different levels of the treatments on Leaf Chlorophyll is presented in Table 9. At 4 WAT, the result showed that application of 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} produced significantly higher leaf chlorophyll (65.2 and 62.6) and the lowest was due to the 0 kg ha^{-1} (45.8 and 30.9) at BUK and Tafa respectively. Among the manure tea treatments applied, poultry litter tea at 100 ml m^{-2} (53.1) and plant tea at 300 ml m^{-2} (55.1) produced the highest leaf chlorophyll at BUK, while compost tea at 300 ml m^{-2} (55.2) and plant tea at 300 ml m^{-2} (54.3) were the highest at Tafa.

At 6 WAT, the result showed significant differences among the treatments. Application of 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} produced significantly higher leaf chlorophyll (73.4, 93.7) and the lowest was due to the 0 kg ha^{-1} (54.0 and 41.7) at BUK and Tafa respectively. Among the manure tea treatments applied, compost tea at 300 ml m^{-2} (71.1)

Table 8. Effect of Organic Manure Tea on Leaf Chlorophyll of Tomato at Bayero University,Kano (BUK) and TafaDuring the 2017/2018 Dry Season.

	Weeks After Transplanting (WAT)							
	4		6		8		Harvest	
Treatments	BUK	Tafa	BUK	Tafa	BUK	Tafa	BUK	Tafa
0 kg ha^{-1}	45.8^{d}	30.9^{g}	50.0^{g}	41.7^{g}	49.8^{f}	50.6^{g}	37.8^{h}	52.1^{g}
(125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1})	65.2^{a}	62.6^{a}	73.4^{a}	93.7^{a}	86.8^{a}	94.5^{a}	83.0^{a}	91.8^{a}
Poultry Litter Tea (ml m^{-2})								
100	53.1^{b}	43.7^{f}	53.9^{f}	51.4^{f}	67.96^{e}	80.7^{e}	50.2^{f}	72.9^{f}
200	47.7^{c}	44.5^{f}	65.9^{c}	56.3^{e}	68.7^{e}	81.2^{e}	66.2^{c}	73.7^{f}
300	46.1^{d}	51.3^{c}	62.1^{d}	63.4^{c}	75.8^{c}	88.2^{c}	55.1^{e}	80.5^{d}
Compost Tea (ml m^{-2})								
100	43.2^{de}	50.3^{d}	60.2^{de}	61.1^{d}	74.5^{d}	84.3^{d}	60.9^{d}	79.5^{e}
200	41.4^{e}	52.2^{c}	55.8^{f}	63.2^{c}	76.4^{bc}	80.0^{e}	65.4^{c}	81.4^{cd}
300	50.1^{c}	55.2^{b}	71.1^{b}	66.0^{b}	79.4^{b}	90.3^{b}	75.4^{b}	84.4^{b}
Plant Tea (ml m^{-2})								
100	41.3^{e}	48.9^{e}	59.7^{e}	52.7^{ef}	73.1^{d}	80.4^{e}	53.7^{ef}	78.1^{e}
200	42.5^{e}	52.1^{c}	56.1^{e}	62.3^{d}	78.6^{c}	75.3^{f}	43.4^{g}	80.7^{d}
300	55.1^{b}	54.3^{b}	67.9^{b}	64.1^{c}	79.5^{b}	89.1^{c}	66.6^{c}	82.5^{c}
SE±	2.17	2.21	3.51	1.83	3.22	3.91	2.38	2.19

*Means followed by the same letter(s) within column are not significantly different ($P \leq 0.05$), using SNK Test.

and plant tea at 300 ml m^{-2} (67.9) produced the highest leaf chlorophyll at BUK whereas compost tea at 300 ml m^{-2} (66) was the highest at Tafa.

At 8 WAT, the result also showed significantly higher leaf chlorophyll due to 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} (86.8 and 94.5) and the lowest were due to the 0 kg ha^{-1} (49.8, 74.6) at BUK and Tafa respectively. Among the manure tea treatments used, compost tea at 300 ml/m^2 (79.4), compost tea at 200 ml/m^2 (76.4) and plant tea at 300 ml/m^2 (79.5) produced the highest leaf chlorophyll at BUK, while compost tea at 300 ml m^{-2} (90.3) produced the highest at Tafa.

At harvest, the result similarly showed significant differences among the treatments. The highest leaf chlorophyll was due to 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} (83.0 and 91.8) and the lowest was due to the 0 kg ha^{-1} (57.8 and 52.1) at BUK and Tafa respectively. Among the manure tea treatments applied, compost tea at 300 ml m^{-2} (75.4, 84.4) produced the highest leaf chlorophyll at both BUK and Tafa respectively.

4.1.9 Total Dry Matter per Plant (g)

The response of Tomato to different levels of the treatments on total dry matter per plant is presented in Table 9. At 4 WAT, the result showed significantly higher total dry matter per plant due to 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} (0.5g and 0.7g) than all the other treatments applied and the lowest was due to the 0 kg ha^{-1} (0.1g and 0.2g) at BUK and Tafa respectively.

and plant tea at 300 ml m^{-2} (67.9) produced the highest leaf chlorophyll at BUK whereas compost tea at 300 ml m^{-2} (66) was the highest at Tafa.

At 8 WAT, the result also showed significantly higher leaf chlorophyll due to 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} (86.8 and 94.5) and the lowest were due to the 0 kg ha^{-1} (49.8,

Table 9. Effect of Organic Manure Tea on Total Dry Matter per Plant (g) of Tomato at Bayero University, Kano (BUK) and Tafa During the 2017/2018 Dry Season.

	Weeks After Transplanting (WAT)							
	4		6		8		Harvest	
Treatments	BUK	Tafa	BUK	Tafa	BUK	Tafa	BUK	Tafa
0 kg ha^{-1}	0.13^{e}	0.2^{e}	3.6^{g}	5.7^{h}	12.6^{h}	15.3^{f}	22.6^{h}	24.1^{g}
(125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1})	0.5^{a}	0.7^{a}	17.9^{a}	24.2^{a}	36.6^{a}	40.3^{a}	72.8^{a}	80.5^{a}
Poultry Litter Tea (ml m^{-2})								
100	0.2^{d}	0.3^{d}	7.5^{f}	8.5^{g}	20.7^{g}	26.7^{de}	38.4^{g}	44.4^{f}
200	0.2^{d}	0.3^{d}	7.9^{e}	10.9^{de}	23.7^{e}	25.2^{e}	38.9^{g}	45.8^{e}
300	0.3^{c}	0.4^{c}	12.8^{c}	13.5^{c}	26.5^{c}	29.1^{c}	47.3^{d}	55.6^{c}
Compost Tea (ml m^{-2})								
100	0.3^{c}	0.3^{d}	7.8^{e}	10.3^{e}	22.6^{f}	26.2^{de}	40.4^{f}	44.3^{f}
200	0.3^{c}	0.4^{c}	8.1^{e}	11.5^{d}	25.8^{d}	29.4^{c}	41.4^{ef}	49.6^{d}
300	0.4^{b}	0.5^{b}	14.5^{b}	15.1^{b}	28.9^{b}	34.0^{b}	61.8^{b}	66.2^{b}
Plant Tea (ml m^{-2})								
100	0.2^{d}	0.2^{de}	9.7^{d}	9.9^{f}	23.4^{e}	27.1^{d}	44.7^{e}	49.8^{d}
200	0.3^{c}	0.4^{c}	7.7^{ef}	10.5^{e}	25.2^{d}	30.1^{c}	43.6^{f}	50.7^{d}
300	0.4^{b}	0.5^{b}	13.5^{bc}	13.6^{c}	27.6^{bc}	30.7^{c}	57.8^{c}	54.1^{c}
SE±	0.08	0.12	2.06	1.31	3.47	3.62	3.51	4.37

*Means followed by the same letter(s) within column are not significantly different ($P \leq 0.05$), using SNK Test.

74.6) at BUK and Tafa respectively. Among the manure tea treatments used, compost tea at 300 ml/m^2 (79.4), compost tea at 200 ml/m^2 (76.4) and plant tea at 300 ml/m^2 (79.5) produced the highest leaf chlorophyll at BUK, while compost tea at 300 ml m^{-2} (90.3) produced the highest at Tafa.

Among the manure tea treatments applied, compost tea at 300 ml m^{-2} (0.4g and 0.5g) and plant tea at 300 ml m^{-2} (0.4g and 0.5g) produced the highest dry matter per plant at both BUK and Tafa respectively.

At 6 WAT, the result also showed significant difference among the treatments. The highest dry matter per plant was due to 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} (17.9g and 24.2g) and the lowest were due to the 0 kg ha^{-1} (3.6g and 5.7g) at BUK and Tafa respectively. Among the manure tea treatments applied, compost tea at 300ml m^{-2} (14.5g and 15.1g) produced the highest dry matter per plant at BUK and Tafa respectively, which were statistically at par with plant tea at 300 ml m^{-2} (13.5) at BUK.

Application of 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} produced significantly higher dry matter per plant at 8 WAT (36.6g and 40.3g) while the 0 kg ha^{-1} (12.6 and 15.3) produced the lowest at BUK and Tafa respectively. Among the manure tea treatments applied, compost tea at 300 ml m^{-2} (28.9g) and plant tea at 300 ml m^{-2} (27.6g) produced the highest dry matter per plant at BUK, while compost tea at 300 ml m^{-2} (34.0g) was the highest at Tafa.

At harvest, the result similarly showed significant difference among the treatments applied. The highest dry matter per plant was due to 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} (72.8g and 80.5g) and the lowest was due to the 0 kg ha^{-1} (22.6g and 24.1g) at BUK and Tafa respectively. Among the manure tea treatments used, compost tea at 300 ml m^{-}

^{2}(61.8g and 66.2g) produced the highest dry matter per plant at both BUK and Tafa sites respectively.

4.1.10 Crop Growth Rate (g wk^{-1})

The response of Tomato to different levels of the treatments on crop growth rate is presented in Table 11. The result showed significantly higher crop growth rate due to 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} between 4 and 6 WAT (19.3 and 26.11) than all the other treatments applied, at both BUK and Tafa respectively, so also between 8 WAT and Harvest (40.22 and 44.67).The lowest crop growth rate were due to the 0 kg ha^{-1} (3.86 and 6.11) between 4 and 6 WAT and (11.11 and 9.78) between 8 WAT and Harvest at both BUK and Tafa respectively. Among the manure tea treatments applied, compost tea at 300 ml m^{-2} (15.67, 16.22) produced the highest crop growth rate at both BUK and Tafa respectively between 4 to 6 WAT. Similarly, between 8 WAT to harvest compost tea at 300 ml m^{-2}(36.56 and 35.78) produced the highest crop growth rate at both BUK and Tafa respectively.

4.1.11 Relative Growth Rate ($g^{-1}g^{-1}wk^{-1}$)

The response of Tomato to different levels of the treatments on relative growth rate is presented in Table 11. The result showed significant difference among the treatments on relative growth rate. The Application of 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} produced the highest relative growth rate between 4 and 6 WAT (0.78 and 0.93) and also between 8 WAT and Harvest (0.83 and 0.92) at BUK and Tafa respectively. 0 kg ha^{-1} produced the lowest (0.11 and 0.25) between 4 and 6 WAT and (0.36 and 0.44) between 8 WAT and Harvest. Among the manure tea treatments applied, compost tea at 300 ml m^{-2} (0.68) produced the highest relative growth rate at BUK at 4 to 6 WAT, while compost tea at 300 ml m^{-2} (0.81) and plant tea at 300 ml m^{-2} (0.89) were the highest at the same period at

Table 11. Effect of Organic Manure Tea on Crop Growth Rate (CGR) and Relative Growth Rate (RGR) of Tomato at Bayero University, Kano (BUK) and TafaDuring the 2017/2018 Dry Season.

	CGR 6		CGR Harvest		RGR 6		RGR Harvest	
Treatments	BUK	Tafa	BUK	Tafa	BUK	Tafa	BUK	Tafa
0 kg ha^{-1}	3.86^{g}	6.11^{g}	11.11^{i}	9.78^{g}	0.11^{f}	0.25^{e}	0.36^{e}	0.44^{f}
(125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1})	19.33^{a}	26.11^{a}	40.22^{a}	44.67^{a}	0.78^{a}	0.93^{a}	0.83^{a}	0.92^{a}
<u>Poultry Litter Tea (ml m^{-2})</u>								
100	8.11^{f}	9.11^{f}	19.67^{f}	19.67^{f}	0.23^{e}	0.47^{d}	0.58^{d}	0.53^{e}
200	8.56^{f}	11.78^{e}	16.89^{h}	22.89^{e}	0.45^{d}	0.51^{d}	0.54^{d}	0.65^{d}
300	13.89^{d}	14.56^{c}	23.11^{e}	29.44^{c}	0.56^{c}	0.76^{c}	0.67^{c}	0.71^{c}
<u>Compost Tea (ml m^{-2})</u>								
100	8.33^{f}	11.11^{e}	19.78^{f}	20.11^{f}	0.20^{e}	0.53^{d}	0.50^{d}	0.58^{e}
200	8.67^{f}	12.33^{d}	17.33^{g}	22.44^{e}	0.53^{c}	0.62^{cd}	0.58^{c}	0.75^{c}
300	15.67^{b}	16.22^{b}	36.56^{b}	35.78^{b}	0.68^{b}	0.81^{b}	0.77^{b}	0.93^{a}
<u>Plant Tea (ml m^{-2})</u>								
100	10.56^{e}	10.78^{ef}	24.00^{d}	25.82^{d}	0.41^{d}	0.53^{d}	0.45^{d}	0.55^{e}
200	8.22^{f}	11.22^{e}	20.44^{f}	22.89^{e}	0.46^{d}	0.52^{d}	0.64^{c}	0.64^{d}
300	14.56^{c}	14.44^{c}	33.56^{c}	26.00^{d}	0.55^{c}	0.89^{b}	0.61^{c}	0.82^{b}
SE±	0.13	0.07	0.86	1.52	0.016	0.031	0.024	0.035

[*]Means followed by the same letter(s) within column are not significantly different ($P \leq 0.05$), using SNK Test.

Tafa site. Between 8 WAT and harvest, compost tea at 300 ml m^{-2} (0.77, 0.93) produced the highest relative growth rate at BUK and Tafa respectively.

4.1.12 Net Assimilation Rate (g cm^2wk^{-1})

The responses of Tomato to different levels of the treatments on net assimilation rate are presented in Table 12. The result showed significant difference among the treatments. The highest net assimilation rates was due to 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} at 4 to 6 WAT (0.014 and 0.021) and also between 8 WAT to Harvest (0.135 and 0.162). 0 kg ha^{-1} produced the lowest (0.003 and 0.006) between 4 to 6 WAT and (0.015 and 0.043) between 8 WAT to Harvest. Among the manure tea treatments applied, compost tea at 300 ml m^{-2} (0.011 and 0.019) produced the highest net assimilation rate at both BUK and Tafa respectively.

4.1.13 Days to 50% flowering

The responses of the crop to different levels of the treatments on days to 50% flowering are presented in Table 12. The result showed significantly lower number of days to 50% flowering due to the treatments of 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} which resulted in flowering at 35 days after transplanting at BUK site. However, at Tafa site the earliest flowering was influenced by the recommend rate of inorganic fertilizer, Compost Tea at 300ml m^{-2} and plant tea at 300 ml m^{-2} at 28 days after transplanting.

Table 12. Effect of Organic Manure Tea on Net Assimilation Rate (NAR), Days to 50% Flowering and Fruit Brix of Tomato at Bayero University, Kano (BUK) and Tafa During the 2017/2018 Dry Season.

	NAR 6		NAR Harvest		D-50%F		FB	
Treatments	BUK	Tafa	BUK	Tafa	BUK	Tafa	BUK	Tafa
0 kg ha^{-1}	0.003^{h}	0.006^{g}	0.015^{g}	0.043^{g}	42^{a}	42^{a}	3.4^{f}	3.5^{e}
(125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1})	0.014^{a}	0.021^{a}	0.135^{a}	0.162^{a}	35^{e}	28^{c}	3.7^{a}	3.9^{a}
Poultry Litter Tea (ml m^{-2})								
100	0.006^{f}	0.011^{f}	0.064^{f}	0.082^{e}	42^{a}	35^{b}	3.5^{d}	3.6^{d}
200	0.008^{e}	0.012^{ef}	0.070^{e}	0.093^{d}	42^{a}	35^{b}	3.6^{c}	3.7^{c}
300	0.009^{d}	0.014^{d}	0.095^{d}	0.103^{c}	40^{c}	35^{b}	3.6^{c}	3.7^{c}
Compost Tea (ml m^{-2})								
100	0.006^{f}	0.013^{de}	0.081^{de}	0.083^{e}	42^{a}	35^{b}	3.6^{c}	3.7^{c}
200	0.007^{ef}	0.014^{d}	0.091^{d}	0.092^{d}	40^{c}	35^{b}	3.6^{c}	3.7^{c}
300	0.011^{b}	0.019^{b}	0.141^{b}	0.130^{b}	38^{d}	28^{c}	3.7^{a}	3.8^{b}
Plant Tea (ml m^{-2})								
100	0.005^{g}	0.012^{ef}	0.072^{e}	0.076^{f}	42^{a}	35^{b}	3.6^{c}	3.6^{d}
200	0.006^{f}	0.013^{de}	0.083^{de}	0.079^{f}	42^{a}	35^{b}	3.6^{c}	3.7^{c}
300	0.010^{c}	0.017^{c}	0.126^{c}	0.118^{c}	41^{b}	28^{c}	3.6^{c}	3.8^{b}
SE±	0.001	0.002	0.001	0.001	2.4	3.1	0.25	0.17

*Means followed by the same letter(s) within column are not significantly different ($P \leq 0.05$), using SNK Test.

4.1.14 Fruit Brix

The response of Tomato to different levels of the treatments on fruit brix is presented in Table 12. The result showed significant difference among the treatments applied. The highest fruit brix were due to 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} (3.7 and 3.9) which is at par with compost tea at 300 ml m^{-2} (3.7) at BUK , while the highest fruit brix among the manure teas at Tafa was due to compost tea at 300 ml m^{-2} (3.8) and plant tea at 300 ml m^{-2} (3.8) The lowest brix was due to the 0 kg ha^{-1} (3.4 and 3.5) at both sites.

4.1.15 Number of Fruits per Plant

The response of Tomato to different levels of the treatments on number of fruits per plant is presented in Table 13. Application of 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} produced the highest number of fruits per plant (28 and 36) while 0 kg ha^{-1} produced the lowest (9 and 11) at BUK and Tafa respectively. Among the manure tea treatments applied, compost tea at 300 ml m^{-2} (21 and 27) produced the highest number of fruits per plant at BUK and Tafa respectively.

4.1.16 Total Number of Marketable Fruits

The response of Tomato to different levels of the treatments on total number of marketable fruits is also presented in Table 13. The result showed significantly higher total number of marketable fruits due to 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} (25 and 31) than all the other treatments while the lowest were due to the 0 kg ha^{-1} (8 and 8) at BUK and Tafa, respectively. Among the manure tea treatments applied, compost tea at 300 ml m^{-2} (19 and 24) produced the highest total number of marketable fruits per plant followed by plant tea at 300 ml m^{-2} (17 and 22) and poultry litter tea at 300 ml m^{-2} (15 and 21) at both BUK and Tafa respectively.

Table 13. Effect of Organic Manure Tea on Number of Fruits per Plant (NFPP), Total Number of Marketable Fruits (TNMF), Mean Fresh Fruit Weight (MFFW) (g) and Mean Fresh Fruit Diameter (MFFD) (cm) of Tomato at Bayero University, Kano (BUK) and Tafa During the 2017/2018 Dry Season.

	NFPP		TNMF		MFFW		MFFD	
Treatments	BUK	Tafa	BUK	Tafa	BUK	Tafa	BUK	Tafa
0 kg h^{-1}	9^{g}	11^{g}	8^{f}	8^{g}	18.9^{e}	18.1^{f}	2.20^{f}	2.56^{e}
(125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1})	28^{a}	36^{a}	25^{a}	31^{a}	27.2^{a}	28.5^{a}	3.25^{a}	3.41^{a}
<u>Poultry Litter Tea (ml m^{2})</u>								
100	15^{f}	20^{f}	12^{e}	17^{f}	20.4^{d}	22.0^{d}	2.65^{e}	3.14^{cd}
200	15^{f}	21^{e}	14^{d}	17^{ef}	20.9^{cd}	22.6^{d}	2.69^{e}	3.02^{d}
300	17^{d}	24^{c}	15^{cd}	21^{cd}	21.5^{c}	23.9^{c}	2.78^{c}	3.15^{c}
<u>Compost Tea (ml m^{-2})</u>								
100	15^{f}	22^{de}	14^{d}	20^{d}	21.3^{c}	22.5^{d}	2.78^{d}	2.99^{d}
200	18^{cd}	23^{d}	17^{c}	22^{c}	21.4^{c}	23.5^{c}	2.89^{c}	3.07^{d}
300	21^{b}	27^{b}	19^{b}	24^{b}	22.4^{b}	24.7^{b}	2.93^{b}	3.38^{b}
<u>Plant Tea (ml m^{-2})</u>								
100	16^{e}	21^{e}	14^{d}	18^{e}	20.3^{d}	21.3^{e}	2.63^{e}	3.13^{c}
200	16^{e}	22^{de}	14^{d}	20^{d}	20.6^{d}	22.5^{d}	2.82^{c}	3.18^{c}
300	19^{c}	25^{c}	17^{c}	22^{c}	22.6^{b}	24.9^{b}	2.94^{b}	3.25^{bc}
SE±	1.04	1.16	0.91	0.86	1.15	2.64	0.15	0.39

*Means followed by the same letter(s) within column are not significantly different ($P \leq 0.05$), using SNK Test.

4.1.17 Mean Fresh Fruit Weight (g)

The response of Tomato to different levels of the treatments on mean fresh fruit weight is also presented in Table 13. Application of the recommended rate of inorganic fertilizer produced significantly higher mean fresh fruit weight (27.2 and 28.5) than the other treatments applied while the lowest mean fresh fruit weight was due to the 0 kg ha^{-1} (18.9 and 18.1) at BUK and Tafa, respectively. Among the manure tea treatments applied, the highest mean fresh fruit weights were due to compost tea at 300 ml m^{-2} (22.4 and 24.7) and plant tea at 300 ml m^{-2} (22.6 and 24.9) at BUK and Tafa respectively.

4.1.18 Mean Fresh Fruit Diameter (cm)

The response of Tomato to different levels of the treatments on Mean Fresh Fruit Diameter is also presented in Table 13. The result showed significant difference among the treatments applied on mean fresh fruit diameter. 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} produced significantly higher mean fresh fruit diameter (3.25 and 3.41) among the treatments applied, while the 0 kg ha^{-1} produced the lowest (2.20 and 2.56) at BUK and Tafa respectively. Among the manure tea treatments applied, compost tea at 300 ml m^{-2} (2.93 and 2.94) and plant tea at 300 ml m^{-2} (2.94 and 3.25) produced the highest fruit diameter at BUK and Tafa, respectively.

4.1.19 Total Fresh Fruit Weight per Plant (kg)

The responses of Tomato to different levels of the treatments on total fresh fruit weight per plant are presented in Table 14. The result showed significantly higher total fresh fruit weight due to 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} (0.691 and 0.958), while the 0 kg ha^{-1} produced the lowest (0.226 and 0.297) at BUK and Tafa respectively. Among the manure tea treatments applied, compost tea at 300 ml m^{-2} (0.511), plant tea at 300 ml m^{-2} (0.487) and poultry litter tea at 300 ml m^{-2} (0.422) produced the highest total fresh fruit weight

Table14. Effect of Organic Manure Tea on Total Fresh Fruit Weight per Plant (TFFWPP) (kg), Total Fruit Yield per Hectare (TFYPH) (tonnes), Stand Count at 2 WAT and at Harvest per Hectare of Tomato at Bayero University, Kano (BUK) and TafaDuring the 2017/2018 Dry Season.

	TFFWPP		TFYPH		SC2WAT		SCH	
Treatments	BUK	Tafa	BUK	Tafa	BUK	Tafa	BUK	Tafa
0 kg ha^{-1}	0.226^{e}	0.297^{g}	5.022^{f}	6.600^{f}	36666^{ns}	36664^{ns}	16111^{d}	17222^{c}
(125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1})	0.691^{a}	0.958^{a}	15.356^{a}	21.289^{a}	36598^{ns}	36652^{ns}	21111^{a}	22777^{a}
<u>Poultry Litter Tea (ml m^{-2})</u>								
100	0.369^{d}	0.519^{f}	8.200^{e}	11.533^{e}	36666^{ns}	36666^{ns}	17777^{c}	21111^{b}
200	0.373^{d}	0.566^{e}	8.289^{e}	12.578^{de}	36662^{ns}	36663^{ns}	20555^{ab}	21666^{a}
300	0.422^{bc}	0.642^{cd}	9.378^{c}	14.267^{c}	36666^{ns}	36657^{ns}	19444^{b}	21666^{a}
<u>Compost Tea (ml m^{-2})</u>								
100	0.376^{d}	0.587^{d}	8.356^{d}	13.044^{d}	36661^{ns}	36666^{ns}	18333^{bc}	21666^{a}
200	0.449^{c}	0.619^{d}	9.978^{bc}	13.756^{d}	36664^{ns}	36665ns	20000^{b}	21111^{ab}
300	0.511^{b}	0.724^{b}	11.356^{b}	16.009^{b}	36666^{ns}	36666^{ns}	20000^{ab}	21666^{a}
<u>Plant Tea (ml m^{-2})</u>								
100	0.395^{d}	0.562^{e}	8.778^{d}	12.489^{de}	36666^{ns}	36666^{ns}	20555^{ab}	21666^{a}
200	0.402^{c}	0.590^{d}	8.933^{d}	13.111^{d}	36660^{ns}	36662^{ns}	18888^{bc}	21111^{ab}
300	0.467^{bc}	0.665^{c}	10.378^{bc}	14.778^{c}	36665^{ns}	36666^{ns}	20555^{ab}	21666^{a}
SE±	0.18	0.15	0.71	0.98	7.6	9.2	9.7	8.1

[*]Means followed by the same letter(s) within column are not significantly different ($P \leq 0.05$), using SNK Test.

per plant at BUK, whereas compost tea at 300 ml m^{-2} (0.724) produced the highest at Tafa.

4.1.20 Total Fruit Yield per Hectare (kg)

The response of Tomato to different levels of the treatments on total fruit yield per hectare is also presented in Table 14. The result showed significant differences among the treatments. The highest fruit yields were due to 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} (15.356 tonnes and 21.289 tonnes), while the lowest were due to 0 kg ha^{-1} (5.022 tonnes and 6.600 tonnes) at BUK and Tafa, respectively. Among the manure tea treatments applied, compost tea at 200 ml m^{-2} (9.978 tonnes), 300 ml m^{-2} (11.356 tonnes) and plant tea at 300ml m^{-2} (10.378 tonnes) produced the highest yield per hectare at BUK, while compost tea at 300 ml m^{-2} (16.009 tonnes) produced the highest yield at Tafa site.

4.1.21 Stand Count at 2 WAT

The stand count at 2 WAT is presented in table 14. There was no significant difference for stand count at 2 WAT for all the plots at BUK and Tafa.

4.1.22 Stand Count at Harvest per Hectare

The Stand Count at Harvest is presented in Table 14. There were significant differences among the treatments on stand count at harvest. The highest number of stands at harvest were due to 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} (21111) which was at par with compost tea at 300 ml m^{-2} (20000), poultry litter tea at 200 ml m^{-2} (20555) and plant tea at 100 ml m^{-2} (20555) and 300 ml m^{-2} (20555) while the least was 0 kg ha^{-1} (16111) at the BUK while at the Tafa, the stand count at harvest was statistically the same for all the treatments applied except for poultry litter tea at 100 ml m^{-2} (20555) and the 0 kg ha^{-1} (17222).

4.1.23 Correlation

Table 14 shows the correlation matrix between growth and yield characters of Tomato at BUK. Total fruit yield hectare^{-1} was positively and significantly correlated with plant height, leaf area, number of leaves plant^{-1}, number of fruit plant^{-1} and mean fresh fruit weight. Plant height had a positively significant correlation with number of leaves plant^{-1}, number of fruit plant^{-1} and mean fresh fruit weight. However plant height had a no significant correlation with leaf area plant^{-1}. Leaf area plant^{-1} had a positively significant correlation with number of fruit plant^{-1} and mean fresh fruit weight. However, leaf area plant^{-1} had a negative non-significant correlation with number of leaves plant^{-1}. Number of leaves plant^{-1}had a positively significant correlation with number of fruit plant^{-1} and mean fresh fruit weight. Number of fruit plant^{-1} had a negative correlation with mean fresh fruit weight.

Table 15 shows the correlation matrix between growth and yield characters of Tomato at Tafa. Total fruit yield hectare^{-1} was positively and significantly correlated with plant height, leaf area, number of leaves plant^{-1}, number of fruit plant^{-1} and mean fresh fruit weight. Plant height had a positive and significant correlation with leaf area plant^{-1}, number of leaves plant^{-1} and mean fresh fruit weight. However, it had a non-significant yet positive correlation with number of fruit plant^{-1}. Leaf area had a positively significant correlation with number of fruit plant^{-1} and mean fresh fruit weight. However, leaf area had a positive non significant correlation with number of leaves plant^{-1}. Number of leaves plant^{-1} had a positive and significant correlation with number of fruit plant^{-1} and mean fresh fruit weight. Number of fruit plant^{-1} had a negative correlation with mean fresh fruit weight.

Table 14. Simple Correlation Matrix between Growth and Yield Characters of Tomato at Bayero University, Kano (BUK) in 2017/2018 Dry Season.

	1	2	3	4	5	6
Total Fruit Yield	1.00					
Plant Height (8 WAT)	0.291*	1.00				
Leaf Area (8 WAT)	0.362**	0.904*	1.00			
Number of Leaves Plant^{-1} (8 WAT)	0.292**	0.194*	-0.03	1.00		
Number of Fruit Plant^{-1}	0.401**	0.017**	0.052*	0.322**	1.00	
Mean Fresh Fruit Weight	0.854**	0.365**	0.381**	0.359**	-0.035	1.00

*WAT = Weeks after Transplanting

Table 15. Simple Correlation Matrix between Growth and Yield Characters of Tomato at Tafa site in 2017/2018 Dry Season.

	1	2	3	4	5	6
Total Fruit Yield	1.00					
Plant Height (8 WAT)	0.184**	1.00				
Leaf Area (8 WAT)	0.261**	0.172*	1.00			
Number of Leaves Plant^{-1} (8 WAT)	0.328**	0.102**	0.016	1.00		
Number of Fruit Plant^{-1}	0.631**	0.253	0.068**	0.316*	1.00	
Mean Fresh Fruit Weight	0.574**	0.425**	0.286**	0.221**	-0.149*	1.00

*WAT = Weeks after Transplanting

4.1.24 Regression

Figure 1 shows the regression analysis for total fruit yield ha^{-1} and three levels of Compost Tea (100, 200 and 300 ml m^{-2}). At 5% level of significance the result indicated that 99.1% of total variation (coefficient of determination, $R^2 = 0.991$) for yield could be accounted for by the Compost Tea levels at BUK site.

Figure 2 shows the regression analysis for total fruit yield ha^{-1} and three levels of Poultry Litter Tea (100, 200 and 300 ml m^{-2}). At 5% level of significance the result indicated that 76.5% of total variation (coefficient of determination, $R^2 = 0.765$) for yield could be accounted for by the Poultry Litter Tea levels at BUK site.

Figure 3 shows the regression analysis for total fruit yield ha^{-1} and three levels of Plant Tea (100, 200 and 300 ml m^{-2}). At 5% level of significance the result indicated that 84.4% of total variation (coefficient of determination, $R^2 = 0.844$) for yield could be accounted for by the Plant Tea levels at BUK site.

Figure 4 shows the regression analysis for total fruit yield ha^{-1} and three levels of Compost Tea (100, 200 and 300 ml m^{-2}). At 5% level of significance the result indicated that 91.7% of total variation (coefficient of determination, $R^2 = 0.917$) for yield could be accounted for by the Compost Tea levels at Tafa site.

Figure 5 shows the regression analysis for total fruit yield ha^{-1} and three levels of Poultry Litter Tea (100, 200 and 300 ml m^{-2}). At 5% level of significance the result indicated that 98.2% of total variation (coefficient of determination, $R^2 = 0.982$) for yield could be accounted for by the Poultry Litter Tea levels at Tafa site.

Figure 6 shows the regression analysis for total fruit yield ha^{-1} and three levels of Plant Tea (100, 200 and 300 ml m^{-2}). At 5% level of significance the result indicated that

CT BUK

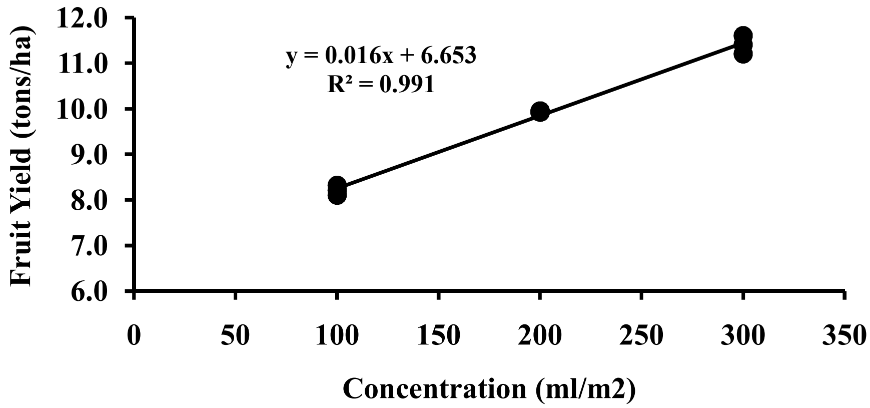

Figure 1.Regression Analysis for Total Fruit Yield ha^{-1} against Compost Tea (CT) Levels at BUK Site.

PLT BUK

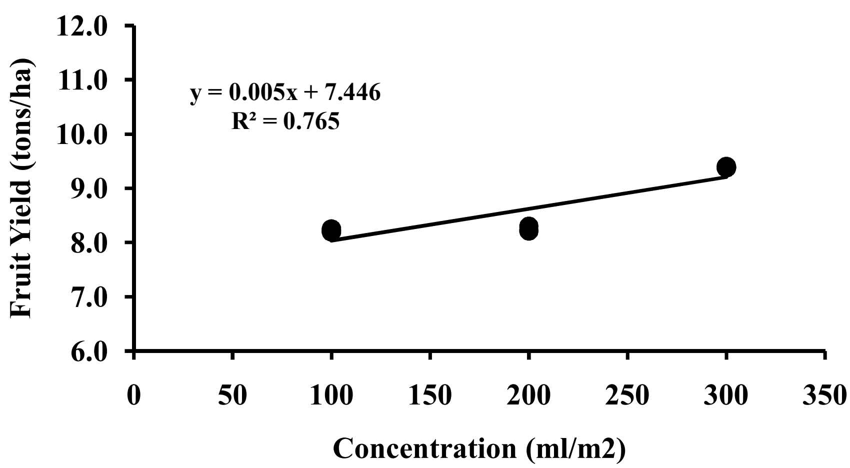

Figure 2.Regression Analysis for Total Fruit Yield ha^{-1} against Poultry Litter Tea (PLT) Levels at BUK Site.

PT BUK

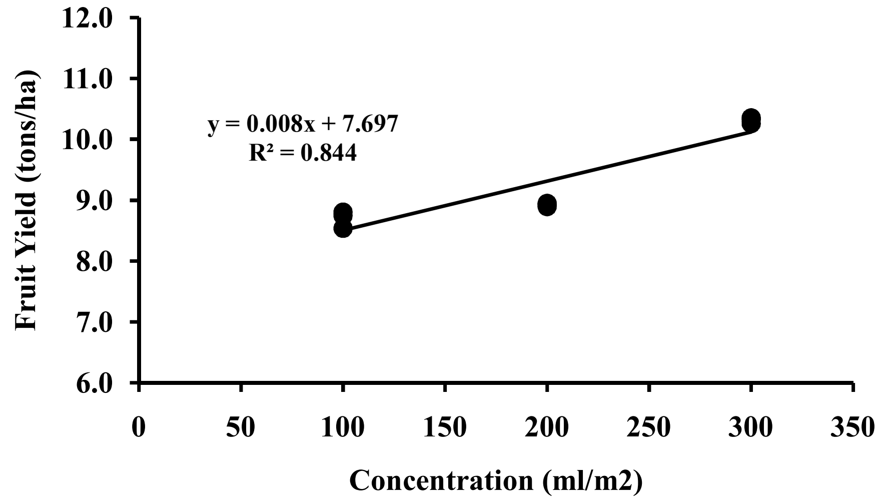

Figure 3.Regression Analysis for Total Fruit Yield ha^{-1} against Plant Tea (PT) Levels at BUK Site.

CT TAFA

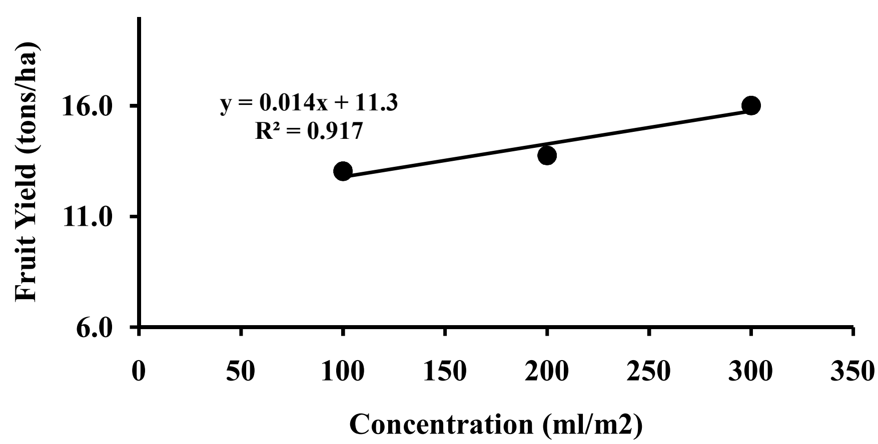

Figure 4.Regression Analysis for Total Fruit Yield ha^{-1} against Compost Tea (CT) Levels at Tafa Site.

PLT TAFA

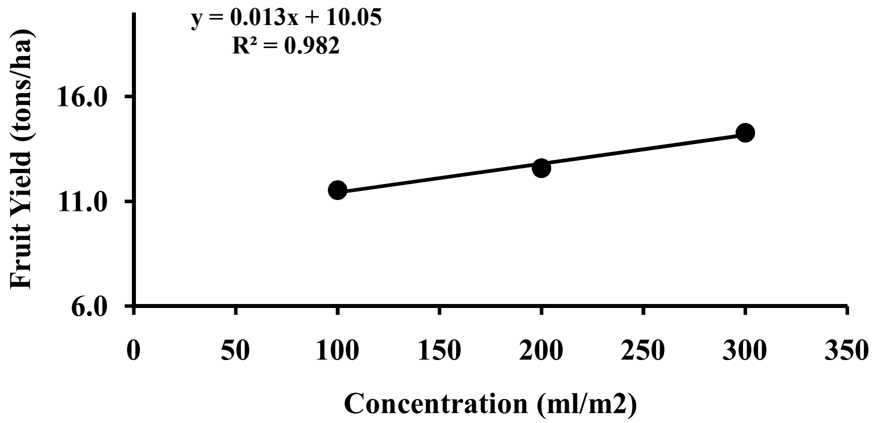

Figure 5.Regression Analysis for Total Fruit Yield ha^{-1} against Poultry Litter Tea (PLT) Levels at Tafa Site.

PT TAFA

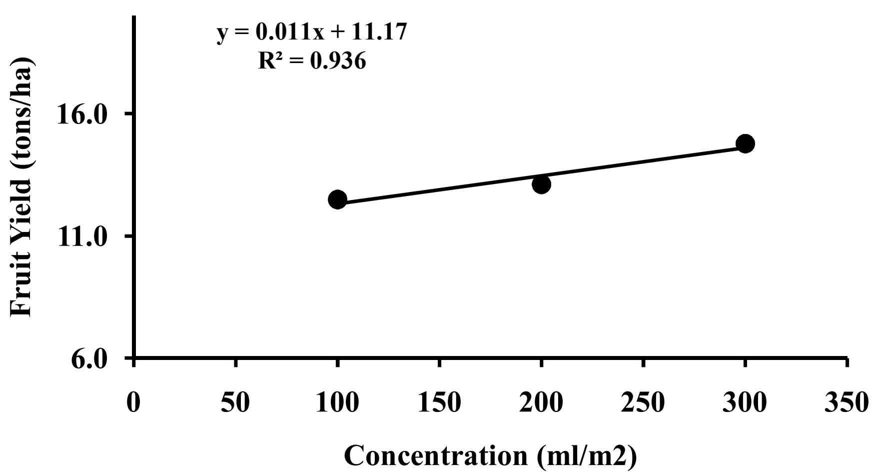

Figure 6.Regression Analysis for Total Fruit Yield ha^{-1} against Plant Tea (PT) Levels at Tafa Site.

93.6% of total variation (coefficient of determination, R^2 = 0.936) for yield could be accounted for by the Plant Tea levels at Tafa site

4.1.25 Cost Analysis

Table 16 shows the cost analysis for compost tea treatments. The total fixed cost for the preparation and application of compost tea at the rates of 100, 200 and 300 ml/m^2 for 1 hectare of tomato were estimated as ₦88,800, N177,629 and ₦265,000, respectively and the total variable costs were estimated as ₦112,326, ₦212,294 and ₦312,248, respectively.

Table 17 shows the cost analysis poultry litter tea treatments. The total fixed cost for the preparation and application of compost tea at the rates of 100, 200 and 300 ml/m^2 for 1 hectare of tomato were estimated as ₦88,888, ₦177,629 and₦265,000, respectively and the total variable costs were estimated as ₦108,684, ₦204,944 and ₦301,248, respectively.

Table 18 shows the cost analysis for plant tea treatments. The total fixed cost for the preparation and application of compost tea at the rates of 100, 200 and 300 ml/m^2 for 1 hectare of tomato were estimated as ₦74,000, ₦148,150 and ₦220,500, respectively and the total variable costs were estimated as ₦73,982, ₦135,632 and ₦197,255, respectively.

Table 19 shows the cost analysis for the application of inorganic fertilizer recommended rate. The total cost was estimated as ₦72,900.

Table 20 shows the cost of production other than fertilizer application cost for 1 hectare of tomato. The total cost was estimated at ₦143,000.

Table 16. Cost Analysis for Compost Tea Treatments.

	Compost Tea at 100 ml m^{-2}		Compost Tea at 200 ml m^{-2}		Compost Tea at 300 ml m^{-2}	
Material	VC ha^{-1} (₦)	FC (₦) Ha^{-1}	VC ha^{-1} (₦)	FC (₦) Ha^{-1}	VC Ha^{-1} (₦)	FC (₦) ha^{-1}
Compost	65,400		130,800		196,200	
Jute Bag	12,350		24,691		37,037	
Ropes		14,800		29,629		44,500
Molasses	9,876		19,753		29,629	
Container		74,000		148,000		220,500
Water	-		-		-	
Labour	24,700		37,050		49,382	
Total	**112,326**	**88800**	**212,294**	**177,629**	**312,248**	**265,000**

*VC: Variable Cost, FC: Fixed Cost, Compost: ₦65/kg, Jute bag: ₦100/bag, Ropes: ₦150/rope, Molasses: ₦65/100g, Container: ₦1000/container, Labour: ₦100/hour.

Table 17. Cost Analysis for Poultry Litter Tea Treatments.

	Poultry Litter Tea at 100 ml m^{-2}		Poultry Litter Tea at 200 ml m^{-2}		Poultry Litter Tea at 300 ml m^{-2}	
Material	VC ha^{-1} (₦)	FC (₦) Ha^{-1}	VC ha^{-1} (₦)	FC (₦) Ha^{-1}	VC ha^{-1} (₦)	FC (₦) ha^{-1}
Poultry Litter	61,758		123,450		185,200	
Jute Bag	12,350		24,691		37,037	
Ropes		14,800		29,629		44,500
Molasses	9,876		19,753		29,629	
Container		74,000		148,000		220,500
Water	-		-		-	
Labour	24,700		37,050		49,382	
Total (N)	**108,684**	**88800**	**204,944**	**177,629**	**301,248**	**265,000**

*VC: Variable Cost, FC: Fixed Cost, Poultry Litter: ₦60/kg, Jute bag: ₦100/bag, Ropes: ₦150/rope, Molasses: ₦65/100g, Container: ₦1000/container, Labour:₦100/hour.

Table 18. Cost Analysis for Plant Tea Treatments.

	Plant Tea at 100 ml m^{-2}		Plant Tea at 200 ml m^{-2}		Plant Tea at 300 ml m^{-2}	
Material	VC ha^{-1} (₦)	FC (₦) ha^{-1}	VC ha^{-1} (₦)	FC (₦) ha^{-1}	VC ha^{-1} (₦)	FC (₦) ha^{-1}
Leaves and Twigs	49,291		98,582		147,873	
Cow dung	-		-		-	
Container		74,000		148,150		220,500
Water	-		-		-	
Labour	24,700		37,050		49,382	
Total (N)	**73,991**	**74,000**	**135,632**	**148,150**	**197,255**	**197,255**

*VC: Variable Cost, FC: Fixed Cost, Leaves and Twigs: ₦133/kg, Containr: N3000/container, Labour: N100/hour.

Table 21. Inorganic Fertilizer (125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1}) Application Cost Analysis.

Fertilizer	Cost/Ha (₦)	Total (₦)
NPK	49,500	
Urea	18,400	
Labour	5000	
		72,900

*NPK: ₦7,500/bag, Urea: ₦8000/bag, Labour: ₦100/hour.

Table 22. Production Cost Analysis.

S/N	Operation/Item	Cost/Ha (N)
1	Seed	5,000
2	Nursery	2,000
3	Land Clearing	3,000
4	Tillage	20,000
5	Land Preparation	20,000
6	Transplanting	15,000
7	Irrigation	36,000
8	Weeding	30,000
9	Cost of Pesticide	2,000
10	Harvesting	10,000
		143,000

*Tillage: N8000/acre, Land Preparation: N8,000/acre, Transplanting: N6000/acre, Irrigation: N3000/week, Weeding: N6000/acre, Pesticide: N500/sachet, Labour: N100/hour.

4.1.26 Cost Benefit Analysis

Table 21 shows the cost benefit analysis for BUK site. The results showed that among the manure tea treatments, plant tea at 300 ml m^{-2} gave the highest net farm income of ₦1,191,552 followed by compost tea at 300 ml m^{-2}(₦1,123,534) while the least among the teas was realized from poultry litter tea at 200 ml m^{-2}(₦883,074). In contrast, 125 kg h^{-1} N - 50 kg h^{-1} P_2O_5 - 50 kg h^{-1} K_2O gave a net farm income of ₦970,700 while the 0 kg ha^{-1} gave a net farm income of ₦233,650.

Table 22 shows the cost benefit analysis for Tafa site. The results showed that plant tea at 300 ml m^{-2} (₦1,851,552) gave the highest net farm income among the manure tea treatments applied, followed by compost tea at 300 ml m^{-2} (₦1,821,484) while the least among the manure tea treatments was realized for poultry litter tea at 100 ml m^{-2}(₦1,478,310). In contrast, the inorganic fertilizer recommended rate gave a net farm income of ₦1,415,675 while 0 kg ha^{-1} (₦352,000) gave the lowest among all the treatments.

Table 21. Cost Benefit Analysis of Treatments applied ha^{-1} for BUK.

Treatment	TVC (₦)	TFC (₦)	TC (₦)	TR (₦)	NFI (₦)
(125 kg N ha^{-1} - 50 kg P_2O_5 ha^{-1} - 50 kg K_2O ha^{-1})	215,900	-	215,900	1,151,700	970,700
Poultry Litter Tea ($ml\ m^{-2}$)					
100	251,640	17,777	269,417	1,230,000	978,360
200	347,944	35,555	383,499	1,243,350	883,074
300	444,248	53,000	497,248	1,406,700	937,760
Compost Tea ($ml\ m^{-2}$)					
100	255,326	17,760	273,086	1,253,400	964,709
200	355,294	35,525	390,819	1,496,700	1,062,344
300	455,248	53,000	508,248	1,703,400	1,123,534
Plant Tea ($ml\ m^{-2}$)					
100	216,982	14,800	231,782	1,316,700	1,099,718
200	278,632	29,630	308,262	1,339,950	1,049,046
300	340,456	44,100	384,556	1,556,700	1,191,552
0 kg ha^{-1}	143,000	-	143,000	376,650	233,650

*TVC: Total Variable Cost, TFC: Total Fixed Cost, TC: Total Cost, TR: Total Revenue, NFI: Net Farm Income. Cost of tomato: Inorganic ₦75/kg, Organic ₦150/kg.

Table 22. Cost Benefit Analysis of Treatments applied ha^{-1} for Tafa site.

Treatment	TVC (₦)	TFC (₦)	TC (₦)	TR (₦)	NFI (₦)
0 kg ha^{-1}	143,000	-	143,000	495,000	352,000
(125 kg N - 50 kg P_2O_5 - 50 kg K_2O ha^{-1})	215,900	-	215,900	1,596,675	1,415,675
Poultry Litter Tea (ml m^{-2})					
100	251,640	17,777	269,417	1,729,950	1,478,310
200	347,944	35,555	383,499	1,886,700	1,526,424
300	444,248	53,000	497,248	2,140,050	1,671,110
Compost Tea (ml m^{-2})					
100	255,326	17,760	273,086	1,956,600	1,667,909
200	355,294	35,525	390,819	2,063,400	1,629,044
300	455,248	53,000	508,248	2,406,350	1,821,484
Plant Tea (ml m^{-2})					
PT1	216,982	14,800	231,782	1,873,350	1,656,368
PT2	278,632	29,630	308,262	1,966,650	1,675,746
PT3	340,456	44,100	384,556	2,216,700	1,851,552

*TVC: Total Variable Cost, TFC: Total Fixed Cost, TC: Total Cost, TR: Total Revenue, NFI: Net Farm Income. Cost of tomato: Inorganic ₦75/kg, Organic ₦150/kg.

4.2 DISCUSSION

4.2.1 Location

The locations for the trials vary slightly due to climate and edaphic factors, however both sites are located in the vicinity of an orchard, with the Tafa site additionally in close proximity to a perennial pond of water. This may have an influence on the micro climate of sites, chiefly influencing humidity and wind speed at the sites. Moreover, while the BUK site was located on an upland area, with a sandy loam soil, which was slightly acidic and a low to moderate soil organic carbon, the Tafa site was in a flood plain with a loamy soil, which was moderate in organic carbon and slightly alkaline. These differences were probably responsible for higher vegetative growth and yield obtained at Tafa site compared with BUK site. Higher humidity reduces evapo-transpiration of the plants but also increased soil water retention and pollination which will consequently help to maintain vigour within the plant and fruits and also increase the rate of fruit formation. However due to the time of conduct of the trial, air humidity had little influence on the growth and yield of the plants largely because of the dry and cold weather and high wind speed.

Meanwhile the loamy soil with higher organic carbon and CEC at Tafa site helped to conserve moisture and nutrients for longer periods after application consequently producing plant with better growth and yield than the sandy loam with lower organic carbon and CEC at BUK site.

4.2.2 Fertilization

In all the growth parameters measured, the result showed that 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} showed the highest mean values for the parameters measured, while 0 kg ha^{-1} control showed the lowest. Compost tea at 300 ml m^{-2} showed the best result among the manure teas used while poultry litter tea and plant tea at 300 ml m^{-2} also showed significantly higher mean values compared to the no fertilizer control. The greater growth of the Tomato due to 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} may be attributed to readily available nitrogen in larger quantities.

Compost tea, poultry litter tea and plant tea treatments showed positive response in terms of vegetative growth. These may be related to important role of nitrogen, phosphorus, potassium, Magnesium, Calcium and Sodium in plant processes for good production (Nnabude*et al*. 2015). These processes such as photosynthesis, carbohydrate transfer, protein formation, control of ionic balance, regulation of plant stomata and water use action of plants enzymes etc directly influence vegetative growth of the plant.

The positive response of the crop to 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} and compost tea at 300 ml/m^2 compared to the 0 kg ha^{-1} control could be in response to the role of N and other nutrients supplied by the treatments in larger quantities on cell division and elongation which clearly influences overall plant height and stem diameter.

Ayoola and Adebayo (2017) reported that high concentration of N might have contributed to taller tomato plants since nitrogen is an essential constituent of amino acid necessary for cell division in plants which is responsible for plant growth, resulting in taller plants. Pant *et al.* (2012) reported that compost quality impacted on nutrient extraction efficiency, microbial activity, phyto-hormones and total nutrient content of the extract. These differences in extract quality in turn influences growth and tissue mineral nutrient of Pak Choi (*Brassica rapa*). Ibrahim *et al*. (2018) reported that in conjunction with compost tea as foliar spray or soil drenching with chelates forms EDTA and humic acid micronutrient solutions increased plant height, dry weight and dry weight of seeds, oil percentage and volatile oils in Black Cumin (*Nigella sativa*). High performance in availability, uptake and accumulation of nutrients occurred. NPK percentage increased in seeds and straw of black cumin. Compost tea enhanced the effect of micronutrient on Black Cumin (*Nigella sativa*) productivity and oil content beside the uptake of NPK, when applied in combination (Ibrahim *et al*, 2018).

The higher number of leaves, leaf area and leaf area index due to the application of 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} and compost tea at 300 ml m^{-2}compared to the control could be due to the influence of quantities of nutrients supplied by the treatment on tissue synthesis, photosynthesis and respiration compared to the 0 kg ha^{-1} control which leads to growth and development of leaves and branches on the plants as observed by Direkvandi et al. (2008).

The resulting high leaf chlorophyll for treatments with 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} and compost tea at 300 ml m^{-2} compared to the control is probably due to the increase in production and function of chloroplast which leads to more leaf chlorophyll compared to the control treatment which results in chlorosis and necrosis of the plant leaves, which was similarly reported by Eysinga and Smilde (1981).

The application of 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} and compost tea at 300 ml m^{-2}resulted in higher total dry matter per plant compared to the 0 kg ha^{-1} control is maybe due to the role of supplied nutrients in increasing physiological processes such as photosynthesis and respiration which consequently leads to accumulation plant biomass. Farneselli*et al*. (2018) reported that the highest dry matter values were always associated with the highest LAI and highest N availability, and that crop growth in processing tomato is mainly driven by N availability, which is mainly determined by N rate.

The means showed significant increase in crop growth rate, relative growth rate and net assimilation rate due to the application of 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} followed by compost tea at 300 ml m^{-2} compared to the 0 kg ha^{-1}control. This is likely due to increased number of branches, leaves and dry matter accumulation as influenced by the treatments.

Treatments also showed significant differences on days to 50% flowering, with the application of 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} having the lowest number of days followed by compost tea at 300 ml m^{-2}. This is likely due to the pace of physiological activities within the plant driven by higher photosynthetic and respiratory processes associated with higher N supply and other vital plant nutrients which could lead to faster growth and development of florescence on the plant.

Compost Tea

The yield performance of the crop due compost tea treatments is largely due to more dissolved nutrients in the tea and the presence of more beneficial microorganisms which stimulate root zone microbial activities and soil organic matter decomposition.

Pane *et al*. (2016) reported that compost tea significantly led to yields increase in comparison to control. The remarkable effect of CT on the production of tomato plants could be attributed to treatments that may have contributed in general, to reduce losses of precious leaf area required for light interception, photosynthesis and dry matter production to improve plant growth, vigor and productivity.

Plant Tea

The positive performance of the plant tea treatments on yield could be due the breakdown of plant materials rich in nutrients by microorganisms during the tea preparation process and the subsequent conversion of the nutrients in to plant available forms.

Poultry Litter Tea

The performance of the poultry litter tea treatments was due to high ammonia concentration of poultry litter, as well as other nutrients contained in the undigested poultry feeds which were broken down and converted to plant available forms. Similar findings were reported by Ksheem (2014)

125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1}

In the long term application of manure teas in addition to the supply of readily available plant nutrients, replenishes the soil microbes which aid in decomposition of organic matter and improve the soil structure thereby improving the soil mineral content for longer periods compared with the inorganic fertilizers.

Jigme*et al*., (2015) observed that highest yield was obtained in inorganic treatment due to availability of readily available nutrients in high quantity. The lowest yield in control is due to insufficient supply of plant available nutrients in high quantity in Brocolli plant (*Brassica oleracea*).

4.2.3 Fruit Quality

Application of the manure tea treatments didn't show pronounced changes in the soluble solid content of the fruits. However there was a slight increase in the fruit brix due to the inorganic fertilizer treatment, compost tea at 300 ml $m^{-2}$and plant tea at 300 ml m^{-2}. This increase could be due to external factors such as harvest time and temperature during ripening and at harvest. Higher N content slows the ripening process allowing for bigger fruits at harvest which have accumulated more soluble solids. Beckles (2012) reported that early harvest decimates fruit sugar content; it is also worthwhile investing in optimizing growth conditions i.e nitrogen, phosphorus, potassium ratios, the use of pruning in combination with soil EC to get close to the theoretical maximal at early stages of fruit development. Atherton and Rudich (1986) also reported that treatments that reduce the rate of metabolism or interfere with ethylene synthesis or action can retard or inhibit ripening. Thus, reducing the temperature slows the rate of ripening. However, this may prevent the full development of quality attributes such as colour and flavour. Bertin and Genard (2018) also reported that fruit shape is determined mainly by the genetic make-up and it has been strongly diversified during breeding. While fruit shape poorly depends on the environment, fruit size largely varies in response to genetics, environment and management interactions. The increase in fruit volume results from the development of pericarp tissue, which is achieved through two important processes; the production of new cells which ceases about 10-25 days after anthesis and cell growth and expansion which generally proceeds until start of maturation and maybe limited by epidermal extensibility.

4.2.4 Correlation

Correlation analysis measures the relationship between various plant characters and determines the component characters on which selection could be used for improvement in yield (Mahmud *et al.* 1997). The positive correlation between growth characters and yield indicates that as plant growths the number of fruits increases due to consequent increase in plant height, number of leaves per plant, leaf area per plant and number of branches. Number of fruit plant^{-1} was negatively correlated with mean fresh fruit weight likely due to inverse relation between them due to more competition for sink sites when more fruits are borne on the plants. Halima *et al.* (2016) also reported a positive significant correlation between number of branches of tomato and fruit yield.

4.2.5 Regression

The regression analysis showed that at both sites, there is a linear relationship between the tea levels and total fruit yield ha^{-1}, meaning that higher levels of the treatments are required to determine the optimum concentration of the teas to produce the highest possible yield at each site.

4.2.6 Cost Benefit Analysis

The cost of preparation and application reduced the profitability of the treatment. Moreover, in the short term application of 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} produced high profit, largely due to minimal preparation and application costs but the profit margin was less than some of the manure tea treatments even though the yield was more due to differences in price between the organically and inorganically produced tomato in the market.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY

Field trials were conducted during the 2017/2018 dry season at Bayero University Kano Teaching and Research Farm and Tafa Village, Kafin Hausa LGA Jigawa State in the Sudan savannah ecological zone of Nigeria. The main objective of the research was to evaluate the effect of organic manure tea on the growth and yield of tomato plant in field condition. Eleven treatments were applied i.e Compost Tea at 100, 200 and 300 ml m^{-2}, Poultry Litter Tea at 100, 200 and 300 ml m^{-2}, Plant Tea at 100, 200 and 300 ml m^{-2}, 125 kg N-50 kg P_2O_5-50 kg K_2O ha^{-1} and 0 kg h^{-1} as control. The experiment was laid in a Randomized Complete Block Design with three replications. The organic manure treatments were applied at 3, 4, 5, 6, 7 and 8 WAT while the inorganic fertilizer was applied at 3 and 8 WAT. Growth data was collected at 4, 6, 8 WAT and at harvest while yield data was collected as fruits reach maturity. The result of the findings showed that the recommended rate of inorganic fertilizer increased the growth and yield of Tomato more than all the other treatments while among the manure teas used, compost tea at 300 ml $m^{-2}$was most effective in increasing the growth and yield of the crop. However, plant tea 300 ml m^{-2} was the most economically viable treatment among the all the treatments.

5.2 CONCLUSION

The results of the research showed that plant, poultry litter and compost teas can be used effectively for fertilization of Tomato crop at 300 ml m^{-2} in field condition but compost tea was most effective. Moreover, the results also showed that inorganic fertilization was more effective in increasing the growth and yield of Tomato than the manure teas, although the manure teas were more economically viable due differences in price between the organically and inorganically produced tomato in the market. The benefit of using inorganic fertilizers is also short term considering the gradual reduction in soil productivity due to rapid depleting of nutrients and accumulation of toxic chemical compounds.

Also, the provision of readily available plant nutrients in enough quantities to sustain plant growth and development makes manure teas a viable source of plant nutrients for sustainable farming. In addition, the manure teas replenish soil microorganisms, which aid in the decomposition of soil organic matter, releasing more plant nutrients and also stimulate enhanced biological activities in the rhizosphere of the plants.

Furthermore, the results showed that there is a slight difference in terms of Brix of the fruits as a result both inorganic fertilizer and manure teas used but the differences could be due to the proportion of N in the treatments.

In addition, the regression analysis indicated the need to consider more researches using higher levels for the teas to find an optimum for the highest yield possible in field condition.

5.3 RECOMMENDATIONS

For economic benefit, Plant Tea at 300 ml m^{-2} is recommended for Tomato crop in field condition among the treatments used.

To reduce of organic manure tea application, more researches should be conducted to reduce the need for frequent application in a growing cycle of a crop.

REFERENCES

Adekiya A.O, Agbede T.M (2016). Effect of Methods and Time of Poultry Manure Application on Soil and Leaf Nutrient Concentrations, Growth and Yield of Tomato.Journal of Saudi Society of agricultural Sciences. 16, 383-388.

Atherton J. G. And Rudich J. (1987) " The Tomato Crop: A Scientific Basis for Improvement". Chapman & Hall London. ISBN: 0-412-25120-5.

Atterberg A. (1905). Die RationalleKlassification Der Sande Und Kieser. ChemikerZeitung 29, 195 – 198.

Ayoola O.T., Adebayo A.K. (2017). Response of Local Tomato Varieties to Application of Poultry Manure, Cow-dung and Inorganic Fertilizer.Journal of Biology, Agriculture and Healthcare. 7, 10 (2017) 214-220.

Bray R.H and Kurtz L.T (1945). Determination of Total Organic and Available Forms of Phophorusin Soils. Soil Sci. 59: 39:45.

Brunetti G., Traversa A., De Mastro F., Cocozza C. (2019). Short Term Effects of Synergistic Inorganic and Organic Fertilization on soil Properties, Yield and Quality of Plum Tomato.ScientiaHorticulturae, 252 (2019) 342-347.

Beckles D.M (2019). Factors Affecting the Post Harvest Soluble Solids and Sugar Content of Tomato Fruit. Post Harvest Biology and Technology, 63 (2012) 129-140.

Bertin N. and Gernard M. (2018). Tomato Quality as Influenced by Preharvest Factors. ScientiaHorticulturae 233 (2018) 264-276.

Black C.A, Evans D.D, White J. L and Ensminger L.E (1965). Methods of Soil Analysis.Part 1.Physical and Minerological Properties Including Statistics of Measurement and Sampling. Am. Soc. Agro Inc. Madison, WI.

Cooperband,Leslie R. (2000). "Composting : Art and Science of organic waste conversion to a valuable soil resource." Lab medicine no.31(5):283-290.

Direkvandi N., Najaf S., Alemzadeh A., Sedighie D. (2008).Effect of Different Levels of Nitrogen Fertilizer with Two Levels of Bio-Fertilizers on Growth and Yield of Two Cultivars of Tomato. Asian Journal of Plant Sciences, 7(8): 757-761.

Diver, S. 2002. Notes on Compost Teas:A Supplement to the ATTRA Publication "Compost Teas for Plant Disease Control", Pest Management Technical Note ATTRA & NCAT.

Edwards S. And Araya H. (2011).How to Make and Compost.385-388 pp.

Edosa A., Tsozue T., Eze T. (2015) " Relationship Between Soil Characteristics and Fertility Implications in the Tropics" International Journal of Soil Science. 11(2) : 36-48.

Eysinga R. and Smide N. (1981). Compost Extract on Leaf Chlorophyll of Tomato.HortScience 25: 154-160.

Fatima O.S., Mohammed A.S., Abdul J., Shiyam S.K, Senthilkumar A. (2016). Effect of Some Organic Fertilizers on Growth Yield and Quality of Tomato.International Journal of Natural Sciences. 53, 1-9.

Farneselli M., Tosti G., Onofri A., Benincasa P., Guiducci M., Panacci E. Tei F. (2018). Effects of N sources and Management Strategies on Crop Growth, Yield and Potential N Leaching in Processing Tomato. European Journal of Agronomy 98 (2018) 46-54.

FMA & RD Federal Ministry of Agriculture and Rural Development (2012).Fertilizer Use and Management Practices for Crops in Nigeria. 112pp.

Growth and Employment in States 4 (GEMS4), (2015).Mapping of Tomato Clusters in Northern Nigeria.

Ghorbani R., Koocheki A., Jahan M., Asadia G.A (2008). Impact of Organic Amendments and Compost Extracts on Tomato Production and Storability in Agro-ecological Systems.Agron. Sustain. Dev. 28 (2) 307-311.

Gross, A; R. Arusi, P. fine and A. Nejidat (2008).“Assesment of Extraction Methods with Fowl Manure for Production of Liquid Organic Fertilizers”. Bio-resource Technology no. 99(2):327-334.

Halimatu I.M., Manga A.A., Hussaini M.A., Yahaya S.U., (2016). Effects of Anti-Transpiranta and Moisture Stress on the Performance of Tomato (*SolanumLycopersicon* L.) in the Sudan Savannah of Nigeria.Journal of Applied Sciences. 2(1): 345-350.

Hamoda M.F., Al-wadi S.M. (1996), “Improvement of Effluent Quality for Re-use in Dairy Farm”.www.semanticsscholar.org

Harnandez T., Carmen C., Jose-Luis M., Carlos G. (2014). Towards a More Sustainable Fertilization: Combined Use of Compost and Inorganic Fertilization for Tomato Cultivation. Agricultural Ecosystems and Environment 196 (2014) 178-184.

Hassan M.R., Hossain I., Islam M.R., Khokon M.A.R (2013). Comparative Efficacy of Compost, Compost Tea, Poultry Litter and Bavistan in Controlling Diseases of Chilli. Progressive Agriculture, 24 (182):39-44.

Ibrahim A.K, Renia M.R., Rehab H.H. (2018). Evaluate the Effect of Compost Tea and Some Chelated Micronutrients Forms on Black Cumin Productivity. Springer Nature Switzerland.

Ingham E. (2005). The Compost Tea Brewing Manual. Soil Food Web Incorporated, Oregon, 3:31-32.

Isa A.S., Aman E.B., Odion E.C., Yusuf A.A., (2013). Growth Rate and Yield of Two Tomato Varieties Under Green Manure and NPK Fertilizer Rate at Samaru, Northern Guinea Savannah. International Journal of Agronomy.(2014) 932759.

Jigme, Nipon J., Pathran S., Jirapon I. and Siriwat S. (2015).The effect of Organic Fertilizers on Growth and Yield of Broccoli (Brassica oleracea L.).Journal of Organic Systems, 10 (1).Available online at http://www.organic–systems.org/journal/101.

J M P Statistical Software Package (2018) Version.Developed by SAS Institute Inc., SAS Campus Drive, Cary, North Carolina 27513, USA.

Kelleher, BP, JJ Lealy, AM Henihan, TF O'dwyer, D Sutton and MJ Lealy.2002.Advances in Poultry Litter Disposal Technology, a review." Bio-resource Technology no. 83(1):27-36.

Kirkby E.A. and Johnston A.E. (2008).Soil and Fertilizer PhosPhorus in Relation to Crop Nutrition.Eco-physiology of Plant-Phosphorus Interaction. Springer, 4(3):152-157

Kjeldahl J. (1883). New Method for Determination of Nitrogen in Organic Substances.Zetrchrift for AnalytscheChemie. 22(1): 366-383.

Knapp S (2002). Solanum Section Germinata. F I Neotrop 84:1-405

Ksheem A. M. (2014). Optimising Nutrient Extraction from Chicken Manure and Compost. A Phd Thesis Submitted to the Faculty of Health, Engineering and Sciences, University of Southern Queensland, United Kingdom.

Larney, Francis J., L. Jay Yanke, James J. Miller and Tim A. McAllister. 2003. "Fate of Coliform Bacteria in Composted Beef Cattle Feedlot Manure. Lethbridge Research centre, contribution no. 38702070".

Larry R. and Joanne L. (2007).Genetic Resources of Tomato.In:Razdan Ml, Mattoo AK, editors. Genetic Improvement of Solanaceous Crops.Vol. 2.Enfield, NH Science Publishers; 2007.

Mahmud M., Hussaini M.A., Ibrahim R., and Emans E.B. (1997).Correlation and Path-coefficient Studies on Green Gram (*Vigna radiate* L.) at Samaru, Nigeria.Proc.15thHurt. Conference, NIHORT 67-69.

Mantangu K. D. and Goh K. M. (1990). Effects of Forms and Rates of Organic and Inorganic Nitrogen Fertilizers on the Yield and Some Quality Related Indices of Tomato. New Zealand Journal of Crop and Horticultural Science. 18:1, 31-37.

Martin L. P and Nathan D. (1984). Chicken Manure Tea: Research Report. Echo Technical Note.

Martino C., Fioretto A., Palmieri D. (2019). Effect of Mycorrhizal Fungi on Growth and Yield of Tomato. Springer US: https:// doi/org/10.1007/s00344-019-09923-J.

Massimo Z., Catello P., Domenica V., Assunta M.P., (2018). Compost Spray Increases Yield Performance of Pepper.Italian Journal of Agronomy. (2018) 13: 991.

Meena V.S., Maurya B., Verna J., Meena R., (2016). Pottasium Solubilizing Microorganism in Evergreen Agriculture: An Overview. Springer New Delhi: https:doi.org/10.1007/978-81-322-2776-2-1.

Merrill, Richard, and John McKeon (1998).Organic Teas from Compost and Manures. . Sanza Cruz, California Organic Farming Research Foundation.

Min J.K., Chang K.S., Yong K.K., Sung J. H., Jong H.P., Eun J.H., Jin H.K., Suk C.K. (2015). Effect of Aerated Compost Tea on the Growth Promotion of Lettuce, Soya beans and Sweet Corn in Organic Cultivation. The Plant Pathology Journal, 31 (3): 259-268.

Moon, 1997.“Basic on-farm Composting Manual “Final Report, The Clean Water Washington Centre, Seattle Washington no. 98121.

Omari R. A., Aung H., Hou M., Yokoyama T., Onwona-Agyeman S., Oikawa Y., Fujii Y., Bellingrath S. D. (2016). Influence of Different Plant Materials in Combination with Chicken Manure on Soil Carbon and Nitrogen Contents on Vegetable Yield. Pedosphere 26 (4) : 510-521.

Pant A. P, Radovich T.J, Hue N.V, Paul R.E (2012). Biochemical Properties of Compost Tea Associated with Compost Quality and it’s Effect on Pak Choi Growth. ScientiaHorticulturae 148 (2012) 138-146.

Pane C., Palesa A.M, Spaccini R., Piccolo A., Giuseppe C.And Zaccardelli M. (2016).Enhancing Sustainability of Processing Tomato Cultivation System by Using Bioactive Compost Teas.ScientiaHorticulturae 202 (2016) 117-124.

Passam H.C, Karapanos I., Bebeli P.J, Sawas D. (2007).A Review of Recent Research on Tomato Nutrition, Breeding and Post Harvest Technology with Reference to Fruit Quality. European Journal of Plant Sciences and Biotechnology 1, 1-21.

Peralta I. E., Spooner DM (2007). History Origin and Early Cultivation of Tomato (Solanaceae). In: Razdan M K, Mattoo A K (eds) Genetic Improvement of Solanaceous Crops, Vol 2, tomato. Science , Enfield, pp1-27.

Price M.L. and Duddles N. (1984). Chicken Manure Tea. Echo Technical Note.

Rashidul Islam M.D., Mondal C., Ismail H., Balahar M. (2013), “Compost Tea and Poultry Litter Extract: Alternative Organic Management Approaches for Stem Canker of Potato Caused by *Rhizoctoniasolani”*.Journal of Agricultural Science 5(10): 20-24.

\Ravindran B., Mupawa H.A, Silwana S., Mnkeni P.N. (2017). Assesment of Nutrient Quality, Heavy Metals and Phyto-toxic Properties of chicken Manure on Selected Commercial Vegetable Crops.Heliyon (2017) .

ROU. 2007. Overview of compost tea use in new south wales. www.recycledorganics.com.

Scheurell S. J, Mahaffee W.F. (2006). Compost Tea as a Container Medium Drench for Surpressing Seedling Damping-off Caused by Pythiumultimum. Phytopathology 94 (11), 1156-1163.

Shankara N., Joep V., Narja G., Martin H., and Barbara V. (2005).Cultivation of Tomato.ISBN 90-8273-039.Agromisa, Wageningen.

Singh S., Tripathi K. S, Singh A.K, Patra D.D (2010). Cowpea as a Green Manure to Improve the Productivity of Menthol Mint Intercropping System. Industrial Crops and Products 31 (2010) 289-293.

Song-Juan G., Ju-Sheng G.O, Wei-Dong C.O., Chun-qin Z., Jing H., Jin-Shun B., Fu-Gen D. (2018). Effects of Long Term Green Manure Application on the Content and Structure of Dissolved Organic Matter in Red Paddy Soil. Journal of Integrative Agriculture 17 (8): 1852-1860.

Taiwo L.B, Adediran J. And O.O. Sonubi (2008), "Yield and Quality of Tomato Grown with Organic and Synthetic Fertilizers". International Journal of Vegetable Science 13(2):5-19

Tiquia, Sonia M., and Nora F. Y. Tam (2002). "Characterization and composting of poultry litter in forced aeration piles. Process Biochemistry no. 37(8):869-880.

Vinha A.F, Barrera S.V., Costa A.G, Alves R.C, Oliveira P.P (2014). Organic Versus Conventional Tomatoes: Influence on Physico-chemical Parameters, Bioactive Compounds and Seasonal Attributes. Food and Chemical Toxicology. 67 (2014) 139-144.

Walkey A. And I.A Black (1934). An Examination of the Degtjareff Method for Determining Organic Carbon in Soils: Effect of Variation in Digestion Condition and Inorganic Soil Constituents. Soil SCi. 63: 251-263.

William, C.M., JC Barker and Jisims (1999).Management and Utilization of Poultry Manure Characteristics.FAO.

APPENDIX

Meteorological Data at BUK and Tafa for 2017/2018 Dry Season

	BUK		Tafa	
Month	Relative Humidity	Temperature	Relative Humidity	Temperature
November	29.24	31.6	46.19	23.73
December	22.81	25.14	36.73	18.95
January	13.14	26.47	30.7	19.9
February	10.60	31.81	27.1	22.7
March	22.33	36.01	31.4	30.4
April	24.30	37.56	34.6	32.5
May	43.05	35.29	51.2	31.57

Source: Geography Department, Bayero University Kano and Meteorological Unit, BinyaminuUsman Polytechnic, HadejiaJigawa State.