Centre for Research and Development (CERAD)
The Federal University of Technology, Akure, Nigeria (www.journal.futa.edu.ng)
JoST 2018

Growth and Yield Response of Tomato Plants Grown Under Different Substrates Culture

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ABSTRACT: The knowledge and choice of suitable substrates for growing tomatoes using hydroponic techniques is not known to many. Therefore, this research determines the effect of substrates on optimum growth, yield and nutrient composition of tomato plant so as to form an effective support system to be used for plants in soilless farming methods. This research was carried out at the Department of Agricultural and Environmental Engineering experimental farm, Federal University of Technology, Akure. Tomatoes plants were subjected to two different substrates (rice husk and sawdust) and soil. The study includes agronomic, physiological response, growth, biomass yield, water and nutrient, proximate and mineral composition. The results showed that rice husk gave the highest plant height of 42.74 cm, number of leaves of 120.60 and stem girth of 0.57 cm, respectively while soil gave the lowest plant height of 27.80 cm, number of leaves of 67.40 and stem girth of 0.42 cm. Higher yields were also recorded from rice husk while the soil has the least yield. The physiological appearance and the yields were significantly ($P<0.05$) affected by the various treatments due to effects of the substrates physicochemical features and the planting methods. The proximate and mineral composition of the fruits were higher in the fruit from rice husk and least in the fruits from the soil. These were significantly ($P<0.05$) affected by the treatments effects as a result of its physicochemical features and the planting methods. With the outcome of this research, it is strongly advised that soilless farming should be embraced by farmers in areas where there are limitations of land for agricultural activities.

Keywords: Growth, Yield, Tomatoes, Substrate culture, Hydroponic, Soilless farming methods

JoST. 2018. 9(2): 110-123.
Accepted for Publication, November 23, 2018

INTRODUCTION

Expert experience over the last few years has shown the need to embark on agricultural production with effective technology for better economic prosperity of any nation (OECD, 2001; UNDP, 2012). The present high cost of foodstuff in Nigeria is because of failed agricultural practices over years (Okuneye, 2002; Obayelu, 2010; Olukunle, 2013). If Nigeria has to be rated among the economically powerful countries in the world, our agricultural productivity has to measure up to those countries that are presently rated as economic giant of the world. By implication, the agricultural sector of our economy will need a new and effective technology with ideas that will continually improve the productivity, profitability and sustainability of our country major farming practices (Sanusi, 2010; Plumecocq *et al*, 2018). Therefore, among these technologies and ideas is the greenhouse technology, soilless farming, irrigation, specific crops nutrient and water requirements, etc. Soil is usually the most available growing medium for plants. It provides anchorage, nutrients, air, water, etc. for plant growth (Aatif *et al.*, 2014). It can be defined in many ways to suit different purposes, but to

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agriculturist, soil is the medium for crop growth, anchorage for plants, it contains nutrients, water and air on which plants depend (Ibitoye, 2006; Pawlson *et al*., 2013). However, soils do pose serious limitations for plant growth at time. Some of them are presence of disease causing organisms and nematodes, unsuitable soil reaction, unfavourable soil compaction, poor drainage, degradation due to erosion, etc. (Aatif *et al*., 2014). In addition, Open field agriculture is difficult as it involves large space, lot of labour and large volume of water. In most urban and industrial areas, soil is less available for crop growing, or in some areas, there is scarcity of fertile, cultivable arable lands due to their unfavourable geographical or topographical conditions (Aatif *et al*., 2014). Under such circumstances as stated above, soilless farming method can be introduced successfully (Butler and Oebker, 2006). Soilless farming method is the technique of growing plants in soilless condition with their roots immersed in nutrient solution (Maharana and Koul, 2011). Soilless farming methods of cultivation can be classified according to the techniques employed. It is generally classified into substrate and water culture. Substrate culture is the cultivation of crops in a solid, inert or non-inert medium instead of soil while water culture cultivation of plants directly in nutrient solution circulated with or without any substrate. Soilless farming methods supply fresh vegetables in countries or region of countries with limited arable land as well as in small countries with large populations. It could be useful to provide sufficient fresh vegetables for the indigenous population. In soilless culture, some cultural practices like soil cultivation and weed control are avoided, and land not suitable for crop cultivation can be used (Polycarpou *et al*., 2005). Plants grown by soilless methods had consistently superior quality, high yield, rapid harvest, and high nutrient content. This system will also help to face the challenges of climate change and also helps in production system management for efficient utilization of natural resources and mitigating malnutrition (Butler and Oebker, 2006). Soilless farming can provide important requirements for plant growth with equal growth and yield results compared to field soil (Aatif *et al*., 2014). Terrestrial plants may be grown with their roots in the mineral nutrient solution only or in an inert medium. When the mineral nutrients in the soil dissolve in water, plant roots are able to absorb them. When the required mineral nutrients are introduced into a plant's water supply artificially, soil is no longer required for the plant to thrive. The simplest and oldest method for farming is a vessel of water in which inorganic chemicals are dissolved to supply the nutrients that plants require. The retention of nutrients and water can be further improved with sphagnum peat, vermiculite, or bark chips. These are the most commonly used materials, but others such as rice husk, sugarcane refuse, sedge peat, and sawdust are used sometimes as constituents in soilless mixes. Straw bales have been used as growing medium in England and Canada and Rockwool (porous stone fibre) is used in Europe (Parameshwarareddy *et al*., 2017).The environment where soilless farming is conducted is tightly controlled and regulated wherein the essentials for a plant to successfully grow are amply provided; light, water, nutrition, temperature etc. (Mason, 1988; Jones, 2014c; Jones, 2014a). Therefore, soilless farming usually takes place in either a greenhouse, a modified warehouse or even inside an office building, a place where the environment can be regulated (Mason, 1988). The basic setup requires a few essential things: plant seeds, nutrient-enriched water, light and growing systems. Soilless farming heavily relies on water to function, it interestingly uses almost 90% less water when compared to conventional soil-farming; water in the systems is recycled until the crops are ready for harvest, instead of it washed in water run-offs (Baptista, 2014, Jones, 2014b). This research work aims to comparatively evaluate the potential of organic growing media (sawdust and rice husks) and soil for UC82B variety of tomatoes production, and to examine the effects on yield and fruit quality of tomatoes using drip flow substrate technique hydroponic soilless farming in the greenhouse and conventional farming method respectively.

MATERIALS AND METHODS

This study was carried out at the Department of Agricultural and Environmental Engineering experimental farm, Federal University of technology, Akure, Ondo State, Nigeria on latitude 7° 15′ 9.22′′N and longitude 5° 11′ 35.23′′E. As a tropical area, Akure has a high temperature throughout the year. The average daily temperature is 26°C with a range between 18°C and 35°C. Mean annual relative humidity of about 80% and relief is about 396 m above sea level (Odubanjo *et al*., 2011).UC83B variety of tomatoes (*Lycopersicon esculentum Mill.*) seed bought from National Horticultural Research Institute, Ibadan were sown on drip hydroponic structure using sawdust and rice husk as plant support under greenhouse conditions and conventional farming with soil to serve as control. Simultaneously, samples of sawdust and rice husks were randomly taken from sawmill and rice mill. In addition, soil samples were randomly collected within the depths of 0-15 cm using a hand auger from the Agricultural Engineering experimental farm site where the conventional farming was carried out. Each sample was separately labeled, air-dried, crushed to pass through a 2 mm sieve, and taken to the laboratory for physicochemical analysis to determine their physical properties, chemical properties and nutrient level prior to application of inorganic nutrients/solution. Substrates were put in 3" drilled hole inserted with disposable empty water bottle and filled with sawdust and rice husk in a 4"•4"•72" PVC pipes were laid layout in completely randomized design with three replicates. Treatments consist of two different substrates (sawdust and rice husk) in the drip hydroponic soilless structure as shown in Figure 1 and soil in conventional farming as control to determine the growth and yield of tomatoes plants. The experimental field for the open field farming was cleared, manually tilled prior to planting while the drip hydroponic soilless farming structure is being built. There were five observations of plants on each substrates and soil. The planting space is between 500mm within row and 800mm between rows. It was sown directly in the drip hydroponic planting structure and in the soil on the 13th of March, 2017 at the rate of three seeds per holes and watered every day. Drip hydroponic substrates soilless culture supplied a standard nutrient solution to the plants. The nutrient solution contained: 0.76 g/l sodium nitrate, 0.24 g/l potassium sulphate, 0.25 g/l mono-calcium phosphate, 0.71 g/l magnesium sulphate, 0.27 g/l potassium nitrate, 0.76 g/l calcium nitrate and 0.03 g/l iron sulphate that was used for this research. The electrical conductivity of solution was maintained from 1.5 and 2.5 dS/m. The pH was maintained in the range of 5.8 and 6.5. The volume of nutrient solution applied varied from 1623 to 1912mlfor five observed tomatoes plants in an experimental unit per week. The plants were irrigated 2 times a day with the same nutrient solution until the end of experiment. Irrigation frequency was based on solar radiation and stage of plant growth in greenhouse. Average day and night temperatures in the greenhouse were 31°C and 22°C respectively. The relative humidity varied between 52% and 75%. Data collection on growth and yield began a week after planting and continues every week. Plant height, number of leaves, stem girth, number of flowers, number of fruits, total fruit yield of the crops and biomass yield were measured and evaluated.

Laboratory Analysis

The physicochemical properties of the substrates and the soil were carried out. The moisture content was determined using gravimetric methods as described by Odubanjo

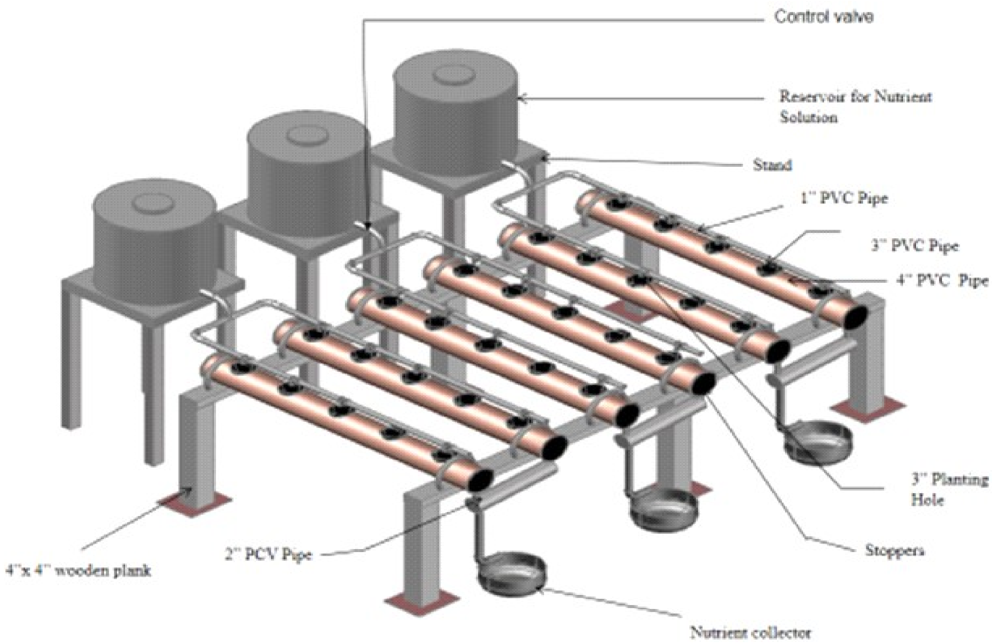

Figure 1: Isometric view of drip hydroponic soilless structure

et al. (2011) while the particle size distribution was determined by the modified hydrometer method (Bouyocous, 1962; Sulieman and Sallam, 2016). Bulk density was determined according to Blake and Hartge, (1986) and Blum *et al*. (2014) by using densimeter, volumetric ring and helium gas pycnometer (model AccuPyc 1330) methods. Porosity was determined using core sampler with known volume and oven dried its content to calculate the total porosity as described by Ibitoye, (2006). The permeability was determined as described by Lock *et al*. (2012).The pH was determined in 0.01 M $CaCl_2$ (1:2 soil and/or substrates/solution ratio while EC was measured by inserting the EC meter into the soil/substrate-water mixture. Exchangeable cations were extracted with 1.0 M ammonium acetate at pH of 7.0. Potassium (K) and Sodium (Na) contents of the extract were determined with flame photometer while Calcium (Ca) and Magnesium (Mg) were determined with an atomic absorption spectrophotometer (Oyedele *et al*., 2009). The effective cation exchange capacity (ECEC) and base saturation (BS) for the soils/substrates were estimated from the data generated. The organic carbon content and organic matter of the soil/substrates were determined by the modified Walkley-Black procedure as described by Nelson and Sommers (1996). The soil total nitrogen was determined with the use of the auto-analyzer. Available micronutrients (Fe, Mn, Zn, Cu and Pb) were extracted by DTPA as described by Sahlemedhin and Taye (2000).

Proximate and Mineral Analysis of the Tomato Fruits

Samples of tomato fruits were plucked from each substrate and the soil. The fruits of tomato were cleaned by rinsing it with deionised water. The samples were freshly blended and stored in the refrigerator (4-8^{0}C) for proximate and mineral analysis test in the laboratory. The proximate composition of tomato was determined using AOAC, (2000) procedure for the determination of moisture content, ash content, protein, crude fibre, fat and energy while the mineral elements comprising sodium, calcium, potassium, magnesium and iron were determined according to the method of Shahidi *et al*. (1999) and Nahapetian and Bassir (1975) with some modifications (Akubugwo, 2007).

Statistical Analyses

Analysis of variance was performed on the data of substrates/soil properties, physiological responses of tomatoes, yield of tomatoes, proximate and mineral composition of its fruits. The means of significant treatment effects were separated with the Least Significance Difference test. All the tests of statistical significance were based on a 5% level of probability.

RESULTS AND DISCUSSION

Physical Properties of the Substrates and the Soil

Result of the sawdust, rice husk and soil samples used as substrates for plants support system of tomato showed the following values of some physicochemical properties as indicated in Table 1. The particle size analysis of the soil at the experimental farm is loamy sand in texture while sawdust and rice husk indicates no sample under particle size classification. A soil's ability to hold and supply nutrients is related to the number of parking spaces for nutrients on soil particles. Since the result of the coefficient of permeability of the sawdust, rice husk and soil has been established to be low, very low and high respectively, it implies that less water/nutrient solution will move through the sawdust and rice husk which economized its use for the crops while the high permeability level of soil result to more water and nutrient been easily drained and not available to crops in the long run. The soil is low in organic matter as reflected by the low content of organic matter (2.98g/kg) which is very low compared to sawdust (9.53g/kg) and rice husk (12.2g/kg). Typical amount of organic matter in soil varies from <1% in ordinary soil to 90% in both peat soil and between 15 to 20% in mineral soils (Awofolu *et al*., 2005; McCauley*et al*., 2017). Organic matter obtained in both substrates and soil was within this range. The relevance of organic matters to this study is its influence on the mobility and flux of extractable bases and micronutrients. The normal range of organic matter obtained signified that metals in soil and substrates are bio-available since these metals are known to form complex with organic matter that influence their availability (Awofolu *et al*., 2005; Ashraf *et al*., 2012). The moisture content of the sawdust, rice husk and the soil are 12.1%, 18.8% and 8.70% respectively (Table 1). Moisture content is related to organic matter; it helps to improve the structures of the substrates as well as water and nutrient holding capacity, support soil microbes and protects soil and the substrates from erosion and competition. Total nitrogen of soil (0.14 g/kg) compared to sawdust (0.5 g/kg) and rice husk (0.65 g/kg). Nitrogen is an important building block of proteins, nucleic acids and other cellular constituents that are essential for all forms of life. Soil pH is a measure of a soil solution's acidity and alkalinity that affects nutrient solubility and availability in the soil/substrates. The pH of soil and rice husk is strongly acidic with a mean value of 5.3 and 5.5 respectively while sawdust has pH of 6.1 that is considered suitable and good better performance of vegetables (Tindal, 1983; Pureseglove, 1991; McCauley *et al*., 2017). However, Soil pH levels near 7 are optimal for overall nutrient availability, crop tolerance, and soil microorganism activity. Soil pH can be modified by using chemical amendments (McCauley *et al*., 2017). The available Sodium (Na), Potassium (K), Calcium (Ca) and Magnesium (Mg) with mean values of (0.77 mg/100g, 2.12 mg/100g and 0.34 mg/100g), (0.34 mg/100g, 0.55 mg/100g, and 0.06 mg/100g), (5.73 mg/100g, 8.18 mg/100g, and 2.11 mg/100g), (1.63 mg/100g, 3.97 mg/100g and 0.84 mg/100g) for sawdust, rice husk and soil respectively were seemingly low compared to the ratings of FMANR (1996) for the ecological zone (Olaniyi

Table 1: Result of mean physical and chemical properties of the substrates and the soil

	Valued Obtained		
Parameters measured	**Sawdust Sample**	**Rice Husk Sample**	**Soil Sample**
Moisture Content	12.1%	18.8%	8.7%
Water Holding Capacity	54	76	14
Total Porosity	46	24	86
Permeability	Low	Very low	High
Bulk Density	0.94 g/cm^3	0.92 g/cm^3	1.41 g/cm^3
Clay	NS	NS	9.5%
Silt	NS	NS	3.8%
Sand	NS	NS	86.7%
pH	6.1	5.5	5.3
EC	470μS/cm	651μS/cm	425μS/cm
Organic Carbon	5.54	7.10	1.73
Organic Matter	9.53 g/kg	12.2 g/kg	2.98 g/kg
Total Nitrogen	0.50	0.65	0.14
Fe	75.3 mg/kg	92.4 mg/kg	188.1 mg/kg
Mn	5.17 mg/kg	6.82 mg/kg	24.4 mg/kg
Zn	18.3 mg/kg	22.9 mg/kg	37.1 mg/kg
Cu	1.10 mg/kg	1.25 mg/kg	5.46 mg/kg
Pb	0.24 mg/kg	0.19 mg/kg	0.82 mg/kg
Na	0.77 mg/kg	2.12 mg/kg	0.34 mg/kg
K	0.34 mg/kg	0.55 mg/kg	0.06 mg/kg
Ca	5.73 mg/kg	8.18 mg/kg	2.11 mg/kg
Mg	1.63 mg/kg	3.97 mg/kg	0.84 mg/kg

Each data is mean of three replicates

and Ojetayo, 2010). A substrate/soil's ability to hold and supply nutrients is related to its cation and anion exchange capacities; these revealed there is need for amendment in form of fertilizer or nutrient solution application to improve the growth and the yield of the vegetables.

Plant Height, Number of Leaves and Stem Girth of Tomato as Influenced by the Substrates and the Soil

There were statistically significant differences ($p<0.05$) among the plant height of tomato on the substrates and the soil as shown in Table 2. The plant height increased as the plant ages. However, testing for the differences among the pair of means, using LSD (0.05), tomato planted on the rice husk has the highest mean plant height of 42.75 cm while that planted on the soil has the least mean plant of 27.80 cm. This agreed with findings of Rodriguez-Ortega *et al*., (2017) which says that plants grown hydroponically had the greatest vegetative growth, characterized by their high leaf and stem biomass and large total area. There was no significant difference between the mean plant height of tomato planted on the rice husk and sawdust but the mean plant height of rice husk was significant different from that of the soil. That is, the rice husk differs from soil but no significant difference to sawdust and sawdust not significant to soil. In term of physiological features of the plant, either rice husk or sawdust can be recommended because the plant height from it produces the highest yield. However, the differences in plant height could be because of irrigation time and difference in physicochemical parameters as rice husk contain high organic matter and others.

The number of leaves of tomato planted on the substrates and the soil is presented in Table 2. The number of leaves increased as the plant mature or ages. There was significant difference

Table 2: Plant height, number of leaves, stem girth of tomato plants grown on the substrates and the soil

Substrates	Plant height (cm)	Number of leaves	Stem girth (cm)
Sawdust	33.01ab	93.50ab	0.4068b
Rice husk	42.75a	120.60a	0.5677a
Soil	27.80b	67.40b	0.4155b

Means that do not share a letter are significantly different at p < 0.05 according to Fisher's Least Significance different (LSD).

($p<0.05$) in the mean number of leaves among the substrates and the soil. However, testing for the differences among the pair of means, using LSD (0.05), the mean highest number of leaves was recorded from rice husk (120.60) while soil had the least mean value of (67.40). This agreed with findings of Rodriguez-Ortega *et al*., (2017) which says that plants grown hydroponically had the greatest vegetative growth, characterized by their high leaf and stem biomass and large total area. The statistical analysis showed significant difference in the number of leaves planted on the substrates. There is no significant difference in mean number of leaves of tomato planted on the rice husk and sawdust; sawdust and soil but there was significant difference in the mean value of rice husk and soil. In term of physiological features of the plant, either rice husk or sawdust could be recommended because the number of leaves from them produces the highest yield. Therefore, the differences in number of leaves could be as a result of irrigation time and difference in physicochemical parameters as rice husk contain high organic matter and others.

The stem girth of tomato planted on the substrates is presented in Table 2. The stem girth increased as the plant mature or ages. The statistical analysis showed significant difference ($p<0.05$) in the stem girth planted on the substrates and the soil. However, testing for the differences among the pair of means, using LSD (0.05), the mean highest stem girth was recorded from rice husk (0.5677 cm) while soil had the least value (0.4155cm). This agreed with findings of Rodriguez-Ortega *et al*., (2017) which says that plants grown hydroponically had the greatest vegetative growth, characterized by their high leaf and stem biomass and large total area. There is no significant difference in the mean stem girth of sawdust and soil but the two were significantly difference to mean of stem girth from rice husk. In term of physiological features of the plant, either rice husk or sawdust could be recommended because the stem girth from these two substrates produces the highest yield. However, the differences in stem girth could be because of irrigation time and difference in physicochemical parameters as rice husk contain high organic matter and others.

The growth parameters can be seen to be increasing with age. The tomato plant growth pattern shows an initial slow growth and then accelerated as observed after the normal slow establishment of the plant. This result agreed with the findings of other researchers Olaniyi and Fagbayide, (1999) and Olaniyi *et al*. (2010) who found that the plant showed growth in height at the beginning rather slowly, increasing to a maximum then slow down again so that the chart obtained by plotting height, number of leaves and stem girth against weeks after planting is an oblique 'S' in shape. Soilless production of tomato crops in greenhouses has increased dramatically in recent years. This is because this system allows nutrition and irrigation to be controlled more efficiently, which generates higher yields (Savvas *et al*., 2013; Urrestarazu, 2013; Kotsiras *et al*., 2016). Generally, this result agreed with findings of Silberbush and Ben-Asher (2001) that organic growing media produced higher yield and number of fruits than conventional growing system in greenhouse vegetable production.

Also, the local substrates constitute a promising alternative to the use of soil. Indeed, these substrates have promoted remarkably vegetative growth of tomatoes plants (Radhouani *et al.*, 2011). This behaviour may be attributed to the great growth of the crop as represented by their plant height, number of leaves and stem girth. Thus, assimilation of nutrients solution was efficient as Radhouani *et al*. (2011) affirmed it.

Yield and Biomass Components of Tomato as Influenced by the Substrates and the Soil

The number of flowers, number of fruits, fruit weight per plant and total fruit yield per hectare of tomato as influenced by different substrates in drip substrates soilless farming system and soil are presented below in Table 3a. Although, there was no significance difference for the number of flowers among the substrates and the soil but higher value was recorded for rice husk (20.20) while soil gave the least value (18.80) as shown in Table 3a. The fruit yield per plant and total fruit yield were not significant difference among the substrates. The highest value was recorded from rice husk (17.20) while soil gave the least value (14.40). The low value of yield obtained for soil might be due to non-development of flowers into fruits as most of the flowers did not develop into fruit. Most of the flowers were dried up and fell off or they might form tiny fruits which shriveled up and fall off without further development which was prevented in case of substrates soilless farming inside the greenhouse.

The fresh weight of leaves, stem and root of tomato plant as influenced by different substrates in drip substrates soilless farming system is presented in Table 3b. Rice husk has the highest value of this component part of the plants. Although, there was no significant different in fresh weight of leaves, stem and root in the three substrates as shown in Table 3b. This agreed with findings carried out that most experiments comparing different substrates for horticultural crops, that the differences were not marked (Voca *et al*., 2007; Borowski, 2012). At the end of the experiment, regardless of the substrates treatment, the plants grown on rice husk and sawdust had the greatest vegetative growth, characterized by their high leaves, stem and root biomass value.

Proximate Analysis and Mineral Composition of Tomato Fruits with the Substrates and the Soil

The results of the proximate analysis and mineral composition of tomato fruits with two different substrates and soil is presented in Table 4. The tomato mineral nutrient composition such as sodium, potassium, calcium, magnesium and iron

Table 3a: Yield components of tomato as influenced by substrates and the soil

Substrates	No. of Flowers/ substrates	No. of Fruits/ substrates	Fruit weight/ substrates (g)
Sawdust	20.00a	16.80a	406.0a
Rice husk	20.20a	17.20a	410.6a
Soil	18.80a	14.40a	368.2a

Means that do not share a letter are significantly different at $p < 0.05$ according to Fisher's Least Significance different (LSD).

Table 3b: Biomass components of tomato as influenced by substrates and the soil

Substrates	Fresh weight of leaves/substrates (g)	Fresh weight of stem/substrates (g)	Fresh weight of root/ substrates (g)
Sawdust	30.35a	193.34ab	38.91a
Rice husk	31.964a	198.63a	39.840a
Soil	30.218a	189.54a	37.232a

Means that do not share a letter are significantly different at $p < 0.05$ according to Fisher's Least Significance different (LSD).

from rice husk and sawdust showed significant influenced by the substrates to that of the soil. There is inconsistency in the nutritional values obtained in this study for the tomato with these support systems. The tomato on rice husk closely followed by sawdust recorded higher nutritive values in some than the soil that served as control. All the substrates used are good sources of quality and mineral elements. The variation in the nutritive values of tomato using different substrates as plant support system might be as a result of environmental effect in which they are grown and chemical composition of the substrates in which they are grown. Contents of magnesium (Mg) calcium (Ca), sodium (Na), potassium (K) and iron (Fe) in tomatoes planted on rice husk were 4.60, 43.33, 12.50, 71.74 and 1.09 mg/g; the value of these mineral content for sawdust were 4.59, 42.84, 12.51, 70.56 and 1.09 mg/g while the value of these mineral content for soil were 4.57, 42.84, 12.46, 70.55 and1.09 mg/g respectively. This agreed with findings of Iliæ *et al.* (2013) that growing method and nutrient solution had significant influence on Mg, Ca, Naand K contents in tomato fruits. Tomatoes with organic substrates achieved significantly greater concentrations of minerals. We found significantly greater concentrations of Mg, Ca, Na and K in tomatoes planted on drip hydroponic substrates planting structure than soil in conventional farming system.The values of measured iron concentration in this study were the same where we observed no significant influence of this minerals in the growing methods which agreed with earlier findings according to Rodrýguez *et al.* (2001) and Iliæ *et al.* (2013). It also agreed with findings of Karppanen *et al.* (2005) and Sainju *et al.* (2014) that experimented the nutrient elements in tomatoes and found that potassium has the highest values while iron has the least values. The outstanding values of the tomato as a source of special nutrient needed in the diet are indicated by the nutritive values. The distribution of minerals needed for human health in the edible portion of plants can be affected by cultural production method as in case of soil according to Russo (1996). Calcium aids the formation of bones (Tesegne, 2015) while iron in the diet serves as a source of blood formation to the body of a man (Kalagbor and Diri, 2014). All the substrates used are good sources of quality and mineral elements. The percentage of moisture content, ash content, crude protein, fat, fibre and energy values of tomato fruits showed significant influenced by the substrates. There is inconsistency in the nutritional values obtained in this study for the tomato with different substrates. The tomato on rice husk closely followed by sawdust recorded higher values of these parameters more than the other (soil) which served as control. Tomato production is currently on the increase in Nigeria partly in recognition of its food values as a source of essentially body building proteins, vitamins and mineral (Vilareal, 1980; Arah *et a*l., 2015). Protein helps in the building up of new cells in the body and enhances growth. Fat in the diet serves as a source of energy in the body of a man (South Pacific Foods, 1995).

Table 4: Proximate analysis and mineral composition of tomato with substrates and the soil (values per 100 g edible portion, Fresh weight basis)

Parameters	% MC	% Ash	% Protein	% Fibre	% Fat	Energy (KJ/g)	% Mg	% Ca	% Na	% P
Sawdust	74.25b	1.13ab	25.62b	8.47b	8.79b	451.49b	4.59a	42.84b	12.51a	70.56b
Rice husk	76.57a	1.14a	26.45a	8.53a	8.84a	453.55a	4.60a	43.33a	12.50a	71.74a
Soil	73.15c	1.10b	25.54c	8.43c	8.12c	451.47c	4.57b	42.84b	12.46b	70.55b

Means that do not share a letter are significantly different.
Mg: Magnesium; P: Phosphorus; Na: Sodium; Ca: Calcium; Fe: Iron; MC: Moisture content; ppm: part per million

CONCLUSION

This study was carried out to evaluate some growth and yield indices of tomato plants using two different organic substrates culture (rice husk and sawdust) of hydroponic soilless farming method inside greenhouse and soil for convectional farming method. Result of the experiment revealed that planting with substrates such as rice husk and sawdust had the highest physiological appearances and growth of the tomato than soil. This suggests that in the absence of the conventional farming techniques in areas where soil cannot adequately support plant growth, any of the substrates may be used to obtain similar or higher result of yield. Therefore, in our growing condition (the substrates – rice husk and sawdust) in drip hydroponic soilless planting system is the most suitable while soil by conventional farming for cultivation of tomatoes plants gave least values in most of the parameters measured. Proximate and mineral analyses show that these crops contain appreciable amount of proteins, energy, fat, fibre and mineral elements. Thus, it can also be concluded that these crops can be grown hydroponically and contribute significantly to the nutrient requirements of man in area where soil for conventional farming cannot support plant development. Also, as growing condition of crops is becoming difficult most especially in urban cities where there is no availability of fertile soil or where the distance to available and fertile soil for crop production is not within reach, people can venture into the production of these crops at their home where there is open structure by adopting soilless farming technique and to help improve the yield and quality of the produce even at where the soil is good so that we can ensure food security of our country. In spite of the close proximity of values obtained for the substrates and the soil, optimization of the management of this system could lead to better results, while avoiding contamination of soils, underground water and aquifers due to the release of fertilizers and other chemicals on soil for crop productions.

REFERENCES

Aatif, H., Kaiser, I., Showket, A., Prasanto, M. and Negi, A.K. (2014). A Review on the Science of Growing Crops Without Soil (Soilless Culture) – A Novel Alternative for Growing Crops. *International Journal of Agriculture and Crop Sciences,* Vol. 7(11): 833-842.

Akubugwo, I. E., Obasi, N. A., Chinyere, G. C. and Ugbogu, A. E. (2007). Nutritional and Chemical Value of *Amaranthus Hybridus L.* Leaves from Afikpo, Nigeria. *African Journal of Biotechnology,* Vol. 6(24): 2833 - 2839

Arah, I. K., Kumah, E. K., Anku, E. K., and Amaglo, H. (2015). An Overview of Post-Harvest Losses in Tomato Production in Africa: Causes and Possible Prevention Strategies. *Journal of Biology, Agriculture and Healthcare*. Vol. 5 (16): 78 – 88.

Association of Official Analytical Chemists, AOAC, (2000). Methods of Analysis, V-1, Chapter 4: 5.

Ashraf, M. A; Maah, M. J and Yusoff, I. (2012). Chemical Specification and Potential Mobility of Heavy Metals in the Soil of Farmer Tin Mining Catchment. *The Scientific World Journa*l. Vol. 2012(3-4): 1-11

Awofolu, O, R., Mbolekwe, Z., Mtshemla, V. and Fatoki, O. S. (2005). Levels of Trace Metals in Water and Sediment from Tyume Stream and its Effect on Irrigated Vegetables, *Water SA*. Vol. 31(1): 87 – 94

Baptista, P. (2014). Water Use Efficiency in Hydroponics and Aquaponics. https://www.brightagrotech.com/water-use-efficiency-hydroponics-aquaponics. Accessed: 04/06/2016.

Blake, G. R and Hartge, K. H. (1986). Bulk density. In: Klute, A. (Ed.). Methods of Soil Analisys: Physical and Mineralogical Methods. 2. Ed. Madson: *American Society of Agronomy*, Vol. (13): 363-375.

Blum, J., Giarola, N. F. B., Pires-da-Silva, A., Filho, O. G., Silva, S. G. C., Eberhardt, D. N and Araújo, S. R. (2014). Assessment of soil physical attributes at sowing row and inter-row under no-till system. *Revista Ciência Agronômica*, Vol. 45(5): 888-895

Borowski, E and Nurzyński, J. (2012). Effect of Different Growing Substrates on the Plant Water Relations and Marketable Fruit Yield Greenhouse Grown Tomato (*Lycopersiconesculentum Mill.*) *Acta Agrobotanica,* Vol. 65:49 - 56

Bouyocous G. J. (1962). Hydrometer method improved for making particle size analysis of soil. *Agronomy Journal*.Vol. 54: 3 - 14

Butler, J. D and Oebker, N. F. (2006). Hydroponics as a Hobby-Growing Plants without Soil. Circular 844.Information Office, College of Agriculture, University of Illinois, Urbana. pp. 1 - 16

Federal Ministry of Agriculture and Natural Resources, FMANR (1996). Soil Fertility Investigation Fertility Ratings, Produced by the Federal Ministry of Agriculture, Lagos, Nigeria. Vol. 5: 5- 16

Ibitoye, A. A. (2006). Laboratory Manual on Basic Soil Analysis, Foladave Publishing Company, Akure. Ondo State. Nigeria. Vol. 2: 1 - 17

Ilić, S. Z., Kapoulas, N. and Milenković, L. (2013). Micronutrient Composition and Quality Characteristics of Tomato from Conventional and Organic Production. *Indian Journal of Agriculture Science*, Vol. 83(6): 651-655.

Jones, J. (2014a). Systems of Hydroponics Culture. Complete Guide for Growing Plants Hydroponically. 1, 1.CRC Press, pp. 206

Jones, J. (2014b). Complete Guide for Growing Plants Hydroponically. Vol. 206: 3-4

Jones, J. (2014c). Hydroponics Application Factors. Complete Guide for Growing Hydroponically. pp. 74

Kalagbor, I and Diri, E. (2014). Evaluation of Heavy Metals in Orange, Pineapple, Avocado Pear and Pawpaw from a Farm in Kaari, Bori, Rivers State Nigeria. *International Res. J. Public Environ. Heal.* Vol. 1(4):87 – 94.

Karppanen, H., Karppanen, P and Mervaala, E. (2005). Why and How to Implement Sodium, Potassium, Calcium and Magnesium Changes in Food Items and Diets. *Journal of Human Hypertension,* Vol. (19):S10 – S19

Kotsiras, A., Vlachodimitropoulou, A., Gerakaris, A., Bakas, N and Darras, A. I. (2016). Innovative Harvest Practices of Butterhead, Lollo Rosso and Batavia Green Lettuce (Lactuca sativa L.) Types Grown in Floating Hydroponic System to Maintain the Quality and Improve Storability. Scientia Horticulturae, Vol. 201:1-9.

Lock, E., Ghasemi, M., Mostofi, M and Rasouli, V. (2012). An Experimental Study of Permeability Determination in the Laboratory, *WIT Transaction on Engineering Sciences,* Vol. 81(10): 365 - 374

Maharana, L and Koul, D. N. (2011). The Emergence of Hydroponics. *Yojana (June).* Vol. 55: 39-40

Mason, J. (1988). Greenhouse Operation. Commercial Hydroponics. Vol. 3(1): 144

McCauley, A., Jone, C. and Olso- Ruts, K. (2017). Soil pH and Organic Matter. Nutrient Management. Module No. 8, Montana State University. pp. 1 - 16

Nahapetian, A and Bashir, A. (1975). Changes in Concentration and Interrelationships of Phytate, P, Mg, Cu, Zn in Wheat during Maturation. *Journal of Agricultura land Food Chemistry,* Vol.32: 1179 - 1182

Nelson, D. W. and Sommers, L. E. (1996). Total Carbon, Organic Carbon and Organic Matter. In: Methods of Soil Analysis, Part

3. Chemical Methods, Sparks, D. L. (Ed.), 2nd Ed., SSSA – ASA. Madison, Wisconsin, USA, 961 – 1010.

Obayelu A. E. (2010). Global Food Price Increases and Nutritional Status of Nigerians: The Determinants, Coping Strategies, Policy Responses and Implications, *Asian Research Publishing Network Journal of Agricultural and Biological Sciences*. Vol. 5(2): 67 - 76

Odubanjo, O.O., Olufayo, A.A and Oguntunde, P.G. (2011). Crop Water Productivity of an Irrigated Cassava in South Western Nigeria. *Journal of Applied Tropical Agriculture,* Vol. 17(2): 203-214.

Odubanjo, O. O., Fasinmirin, J. T., Oguntunde, P. G and Olufayo, A.A. (2013). EC H_2O Probe Calibration for Soil Moisture Content Determination in the Tropical Climate of Akure, Nigeria. *International Journal of Agricultural Science*. Vol. 3(9): 718 - 727

Okuneye P. A. (2002). Rising Cost of Food Prices and Food Insecurity in Nigeria and Its Implication for Poverty Reduction, Central Bank of Nigeria Economic and Financial Review, Vol. 39(4): 1 - 16

Olaniyi, J. O., Akanbi, W. B., Adejumo, T.A and Akande, O. G. (2010). Growth, Fruit Yield and Nutritional Quality of Tomato Varieties. *African Journal of Food Science*. Vol. 4(6): 398 - 402

Olaniyi, J.O. and Fagbayide, J.A., (1999). Performance of Eight F1Hybrid Cabbage *(Brassica oleracea L)* Varieties in the Southern Guinea Savanna Zone of Nigeria. *Journal of Agricultural Biotechnology Environment,* Vol. 1: 4 - 10

Olaniyi, J. O and Ojetayo, A.E. (2010). The Effect of Organomineral and Inorganic Fertilizers on the Growth, Fruit Yield and Quality of Pepper *(Capsicum frutescene*). *Journal of Animal and Plant Sciences,* Vol. 8 (3): 1070 – 1076

Olukunle, O.T. (2013). Challenges and Prospects of Agriculture in Nigeria. The Way forward. *Journal of Economics and Sustainable Development*. Vol. 4 (16): 37-45

Organisation for Economic Co-operation and Development, OECD, (2001). Adoption of Technologies for Sustainable Farming Systems, Wageningen Workshop Proceedings. pp.2 - 96

Oyedele, D. J., Awotoye, O. O and Popoola, S. E. (2009). Soil Physical and Chemical Properties under Continuous Maize Cultivation as Influenced by Hedgerow Trees Species on an Alfisol in South Western Nigeria. *African Journal of Agricultural Research.* Vol. 4(7): 736-739

Parameshwarareddy, R., Angadi, S.S and Biradar, M.S. (2017). Effect of Drip Irrigation Levels and Substrates on Growth, Yield and Quality of Tomato under Protected Condition. *The Bioscan, an International Quarterly Journal of Life Science,* Vol. 12(1): 447-452.

Pawlson, D. S., Smith, P and Nobili, M. D. (2013). Soil Conditions and Plant Growth. Blackwell Publishing Ltd, New Jersey, United States. pp. 1 - 449

Plumecocq, G., Debril, T., Duru, M., Magrini, M. B., Sarthou, J. P and Therond, O. (2018). The Purality of Values in Sustainable Agriculture Models: Diverse Lock-in and Coevolution Patterns. *Ecology and Society*, Vol. 23(1): 21

Polycarpou, P., Neokleous, D., Chimonidou, D and Papadopoulos, I. (2005). A Closed System for Soilless Culture Adapted to the Cyprus Conditions. 237 -241

Pureseglove, J. W. (1991). Tropical Crops, Dicotyledons. Longman, London. pp. 34

Radhouani, A., El Bekkay, M. and Ferchichi, A. (2011). Effects of Substrate on Vegetative Growth, Quantitative and Qualitative Production of Muskmelon (*Cucumismelo*) Conducted in Soilless Culture. *African Journal of Agricultural Research,* Vol. 6(3): 578 – 585

Rodriguez-Ortega, W. M., Martinez, V., Nieves, M., and Camara-Zapata, J. M. (2017). Agronomic and Physiological Response of Tomato Plants Grown in Different Soilless Systems to Saline Conditions. *Peer Journal, Preprints*. Vol. 1: 1 - 33

Rodrýguez, A., Ballesteros, A., Ciruelos, A., Barreiros, J. M. and Latorre, A. (2001). Sensory Evaluation of Fresh Tomato from Conventional, Integrated and Organic Production. *Acta Horticulturae*, Vol. 542: 277-282.

Russo, V.M., (1996). Cultural Methods and Mineral Content of Eggplant *(Solaniummelongena)* Fruits. *Journal of Science Food Agriculture,* Vol. 71: 119–123

Sahlemedhin, S and Taye, B. (2000). Procedures for Soil and Plant Analysis. National Soil Research Centre, Ethiopian Agricultural Research Organization, Addis Ababa, Ethiopia, 110

Sainju, U. M., Dris, R and Singh, B. (2014). Mineral Nutrition of Tomato. *Research Gate*. January 2003 Edition. pp. 1 - 8

Sanusi L. S. (2010). Growth Prospects for Nigeria Economy, Convocation Lecture Delivered at the Igbinedion University 8 Convocation Ceremony, Okada, Edo State. pp. 1 - 9

Savvas, D., Gianquinto, G., Tuzel, Y and Gruda, N. (2013). Soilless Culture. FAO Plant Production and Protection Paper No. 217: Good Agricultural Practices for Greenhouse Vegetable Crops. pp. 1 - 11

Shahidi, F., Chavan, U. D., Bal, A. K and Mckenzie, D. B. (1999). Chemical Composition of Beach Pea (*Lathyrus MaritimusL.*) Plant parts. *Food Chem.* Vol. 64: 39-44.

Silberbush, M. and Ben-Asher, J. (2001). Simulation Study of Nutrient Uptake by Plants from Soilless Cultures as Affected by Salinity Buildup and Transpiration. *Plant and Soil,* Vol. 233, 59–69

South Pacific Foods, (1995). Green Leaves. In: South Pacific Foods Leaflets. South Pacific Commission, Community Health Services. pp. 1 - 6

Suliemen, M and Sallam, A. E. (2016). Improved Method to Determine Particle Size Distribution for Some Gypsiferous Soils. A Case Study from Al-Ahsa Governorate, Saudi Arabia. *Eurasian Soil Science*. Vol. 5(4): 322-331

Tesegne, W. A. (2015). Assessment of Some Heavy Metals Concentration in Selected Cereals Collected from Local Markets of Ambo City, Ethiopia. *Journal of Cereals and Oilseeds*, Vol. 6(2): 8 – 13

Tindal, H.D. (1983). Vegetables Crops of the Lowland Tropics. Oxford University Press, Oxford, 101–125

United Nations Development Programme, (UNDP), (2012). Nigeria's Path to Sustainable Development through Green Economy, Country Report to the Rio + 20 summit. pp. 1 - 11

Urrestarazu, M. (2013). State of the Art and New Trends of Soilless Culture in Spain and in Emerging Countries. *Acta Horticulturae,* Vol. 1013:305-312

Vilareal, R. L. (1980). Tomato in the Tropics. West View Press Boulder, Colorado. pp. 174

Voca, S., Dobricevic, N., Sindrak, Z., Borosic, J and Benko, B. (2007). Quality of Tomatoes Grown on Different Substrates and Harvested in Three Harvest Periods. Vegetables Crops Department, Svetosimunska, Croatia. Vol. 72(4): 351 - 355