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"BEST OUT OF KITCHEN WASTE" – AN ECO FRIENDLY GROWING STRATEGY FOR *LYCOPERSICON ESCULENTUM*

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Abstract: Increasing population and increasing demands on food and other necessary items leads to the need of introducing new agricultural methods. The introduction of unconventional agricultural methods after green revolution leads to many issues. It equally affected the sustainability of nature and organisms. Present investigation mainly conducted for encouraging natural organic farming methods to overcome the use of chemical fertilizers and formulate sustainable agriculture. Different types of kitchen wastes were separately collected and used as the bio manures for the investigation. Effect of the different types of kitchen waste alone and in mixture of the kitchen wastes on *Lycopersicon esculentum* was studied. The plant showed different growth response on different kitchen waste. The difference in their disease resistance capacity, thickness and colour changes in their plant body were also noted. The pH level and NPK content in the soil were also analysed.

Key words: sustainable development, natural organic farming, *Lycopersicon esculentum*

1. INTRODUCTION

Since the ever increasing population of human beings on earth demands production of more food, water livelihood, it was necessary to introduce modern agriculture practices like intensive tillage, monoculture, and application of inorganic fertilizer, irrigation, chemical pest control, and genetic manipulation of crop plants.

Out of numerous methodologies for sustainable agriculture, various techniques like mixed cropping, mulching and rotational cropping and livestock used in natural farming are the inclusions in the traditional agriculture are practiced in India in past. It dates back to Neolithic age in the mid Holocene epoch (2500 to 1500 BC) where the citation of organic farming was in practice as per the Mahabharat (5500 BC) the Rig-Veda, the Atharva Veda, (1000 BC), the Kautilya Arthasastra (300 BC), the Quran (590 BC) in India. The basic advantages of organic farming is sustainable, self- balancing, environment friendly, protecting neighbouring flora and fauna, diminishing weed infestation by rotational farming, only harnessing nature, regenerative capacity, indigenous knowledge, optimization of input and perfect nutrient and resource conservation.

Sustainable agriculture can be defined as a set of practices that conserve resources and the environment without compromising human needs and the use of organic fertilizers such as animal manure has been indicated as one of its main pillars (Tilman et al. 2002). This review assesses the potential end uses and sustainable market for this organic residue. Processing of kitchen waste material through composting, reduces the environmental risk by transforming the material into safer and more stable product suitable for application to soil (Lazcano et al. 2009), and also reduces the transportation costs. Composted materials are therefore gaining acceptance as organic fertilizers in sustainable agriculture, and there has been a considerable increase in research dedicated to the study of the effects of compost on soil properties and plant growth.

Land resources of the country are degrading at an alarming rate causing environmental problems. Because of continued cultivation, the soils are becoming low and deficient in organic matter contents (Baloch et al. 2014). Along with implanting the organic farming it is necessary to take steps to conserve land resources. The principle goal of agriculture is the production of high quality safe and affordable food for an ever increasing worldwide population.

Usually huge quantities of vegetables, fishes, meats, and bones remain unutilized or thrown away as wastes in daily household affairs. However, kitchen wastes can also be used in productive manners. The ways and means of this endeavour has been addressed in this communication. The kitchen waste based organic fertilizer has been developed by digging pits and placing the wastes on a six layer of soil, topped by a layer of plant growth-promoting microbes. The main objectives were achieved by converting waste into resource finding an alternative nutrient source for agricultural production; improving soil health and converting recycle elements to natural resources.

2. MATERIALS AND METHODS

Materials

Easily available organic degradable materials were collected from home, dried them and sorted into different categories and named. Seeds of test plant *Lycopersicon esculentum* (Thakkali) were chosen from home yard. The healthy hand sorted undamaged seeds were selected and washed with water. Sand, cow dung, and ashes were used as potting mixtures. Organic manures tea waste, onion peel, egg shell and kitchen waste mixture were separately collected from author's home kitchen. Collection of potting mixtures, seeds, organic manures were from the same locality. The whole materials were collected in duration of one month.

Organic manure preparation

The selected organic manures including tea waste, onion peel, eggshell, kitchen waste mixture were easily available waste materials. All these materials were separately collected from kitchen in separate bins. The potting mixture made of ash and cow dung in 1:1 ratio along with soil was used as control. The organic manures were named as

- EsS - Egg shell (500 gm.) + soil (1 kg.)
- OnS - Onion peel (500 gm.) + soil (1 kg.)
- KwS - Kitchen waste (500 gm.) + soil (1 kg.)
- TwS - Tea waste (500 gm.) + soil (1 kg.)

Investigation phases

The seeds extracted from a healthy fruit were sowed on a dish with normal soil. Drop irrigation was followed for one week. And five healthy seedlings were selected and planted on grow bags which is filled with the same potting mixtures.

The grow bags were placed in a place were enough sunlight was present. After two weeks of germination, each of the organic manures were applied on four of those bags and one plant was selected as control on which only potting mixture was filled. Five replications of such five grow bags were prepared for the study.

Percentage of Survival

Twenty five Plants, five per each group were observed and data collected. Survival percentage in each potting mixture was calculated by the formula.

Survival percentage = (Number of healthy plants / Total number of plants cultivated) x 100

Morphological parameters

Daily observations were conducted on the seedlings in different potting mixtures and the morphological parameters height of the plant, number of leaves, colour and size of the leaves and days taken for flowering and fruiting, nature of fruits were observed. The difference in their disease resistance capacity, thickness and colour changes in their plant body were also noted.

Soil Analysis

Soil in each grow bag was analysed to determine the amount of available plant nutrients in the soil. This analysis helped to find out the variation in nutrient content and pH level of soil after the application of various bio manures compared with control.

Soil sample collection

- The area where the soil sample was taken (grow bag) was cleared of debris and cleaned up.
- Digged a V shaped pit with a shovel (depth approximately 20 cm.)
- Thoroughly chopped and taken in 3 cm. width soil from both sides of the pit.
- Collected the soil and made it free from stones, roots, other plant parts etc.
- The soil was spread in a square shape and divided into four parts.
- After removing any two opposite corner parts the remaining two parts were mixed.
- The above two process was continued until the soil is half a kilogram.
- The resultant soil was kept in a clean place, dried it in shade and packed in polythene bag.
- The soil was collected from each of the five grow bags.

Lab analysis

The separately packed soils were tested at District Soil Testing Laboratory. Test reports received were analyzed for further studies.

3. RESULTS

Organic farming is one of the best methods for agriculture because of its non-harmful effect to humans and soil. Practising organic farming will help as to restore the fertility of the soil. Introducing small scale organic farming to house hold usage will help people to get rid of the usage of vegetables that area cultivated by the application of chemical pesticides and manures.

Along with that survey findings indicate that the pandemic has affected production and marketing through labour and logistical constraints, while the negative income shock restricted access to markets and increased prices of food commodities affecting the consumption pattern. The pandemic wreaked a substantial physical, social, economic and emotional havoc on all the stakeholders of Indian agricultural system. There for the idea of imparting organic farming in small scale on both urban and rural area is beneficial.

Lycopersicon esculentum is one of the most commonly used vegetable in India. The present investigation was conducted for the study of effect of various kitchen waste on the vegetative and reproductive growth of this plant. Healthy hand sorted and undamaged seeds of *Lycopersicon esculentum* were washed in distilled water and the seeds were sun dried. And then soaked in distilled water .Those seedlings were then sown in cleaned soil filled grow bags. After one week, the selected kitchen wastes were applied to these grow bags. Grow bags without applying any kitchen wastes were considered as control.

Growth response of *Lycopersicon esculentum* in different kitchen wastes

The plant showed different growth response on different kitchen waste. The plants showed differences in their shoot length, leaf let length, colour of leaf, days taken for flowering, time taken for fruiting, number of fruits and shape of fruits (Table 1).

Table 1: Growth response of *Lycopersicon esculentum* in different kitchen wastes

Morphological Parameters	**Control**	**TwS**	**OnS**	**EsS**	**KwS**
Shoot length of the plant(cm.)	96 to 97	110 to 112	104 to 106	123 to 127	88 to 90
Length of petiole (cm.)	20 to 22	33 to 36	21 to 23	25 to 27	31 to 33
Days taken for flowering	17 to 20	15 to 17	16 to 18	15 to 19	16 to 18
Days taken for fruitproduction	72 to 75	63 to 65	66 to 68	65 to 67	66 to 69
Number of fruits per plant	4 to 10	28 to 35	12 to 15	16 to 20	8 to 13
Leaf colour	Pale green	Pale green	Green	Dark green	Green
Leaf and stem thickness	Soft	Soft	Medium strong	Strong	Soft
Shape of fruit	Oval small	Oval large	Round large	Round medium	Oval small
Colour of fruits	Pale green	Pale green	Green	Dark green	Pale green

Morphologically, both qualitative and quantitative characters of the *Lycopersicon esculentum* had shown great variation in different kitchen wastes when compared to the control. Leaf variation in colour, length and shapes were also observed in different kitchen waste treatment (Figure 1). Application of egg shell for the tomato plant attained a maximum height (123 cm. to 127 cm.) but the fruit production 28 to 35 numbers per plant was observed in the application of tea waste as a bio fertilizer. Fruits were healthy and oval in shape and large in size (Figure 2). Oval shaped fruits and small in size fruits were in the case of plants grown in control and kitchen waste mixture. Round large fruits were observed in plants grown in onion peel and round medium sized fruits were resulted in plants grown in egg shell. A maximum number of 4 to 10 fruits only attain maturity in the case of control. While the other treatment with16 to 20 per fruits in the case of egg shells, plants in onion peel application had shown a range of 12 to 15 fruits and the same number of fruits per plant were 8 to 13 in the case of kitchen waste mixture.

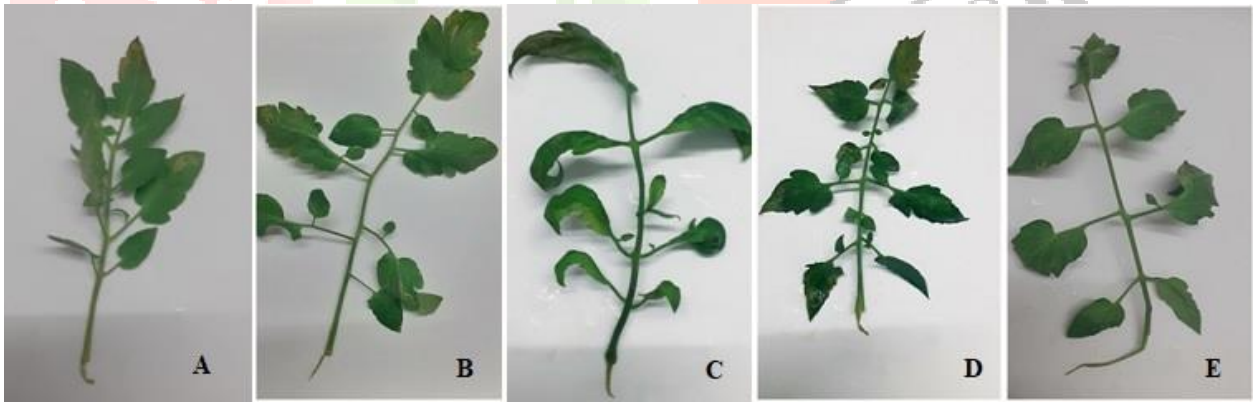

Fig. 1: Leaf variation of *Lycopersicon esculentum* in different potting mixtures.

A, in Control; B, in TwS; C, in OnS; D, in EsS; E, in KwS.

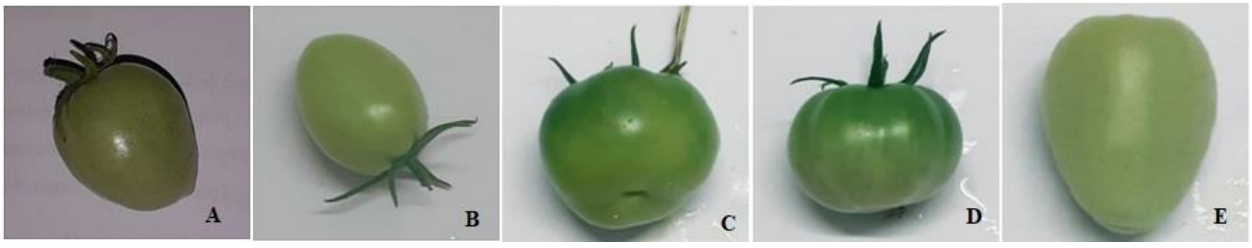

Fig. 2: Fruit variation of *Lycopersicon esculentum* in different potting mixtures.

A, in Control; B, in TwS; C, in OnS; D, in EsS; E, in KwS.

A dark green coloured leaves, fruits and a strong stem was observed in the case of plants grown in egg shell as a bio fertilizer. A minimum number of days (15 to 17) only taken for flowering in the case of plants grown in tea waste as a bio fertilizer.

Soil test analysis

Soil test analysis result was documented in Table 2. From this a comparative study of the characters like pH, amount of organic carbon, phosphorous and potassium present in different kitchen waste in potting mixture and without kitchen waste (control) was possible. An alkaline nature of the soil (pH - 7.80) met in the potting mixture with kitchen waste mixture. A value of pH - 6.80 near to neutral value (7.0) was found in potting mixture added with onion peel. All except kitchen waste mixture were acidic in nature. Highest values of organic carbon (1.98 %), phosphorous (35 Kg/ha) and potassium (400 Kg/ha) were found in potting mixture added with tea waste. Two lowest values for organic carbon was recorded in potting mixture added with onion peel (0.88 %) and control (1.08 %).

Table 2: Soil test analysis of selected potting mixtures

Potting Mixture	pH	Organic Carbon (%)	Phosphorous (Kg/ha)	Potassium (Kg/ha)
Control	6.40	1.08	29	230
TwS	6.60	1.98	35	400
OnS	6.80	0.88	35	400
EsS	6.70	1.53	34	400
KwS	7.80	1.64	35	400

Total suspended solid (TSS) or non-filterable solids was absent in all the soil samples except in potting mixture applied with egg shell (0.200). The best results were observed in the case of each kitchen waste when separately applied in the potting mixture compared to the application of kitchen waste mixture and control.

4. DISCUSSION

The term 'organically grown food' denotes products that have been produced in accordance with the principles and practices of organic agriculture. The use of alternatives to synthetic fertilizers is an important issue in organic systems. Organic fertilization should be supported in order to facilitate reuse and disposal of organic wastes and to maintain and/or increase soil fertility.

Organic plant products are grown without the aid of synthetic pesticides and largely without the use of readily soluble mineral fertilizers in a setting that includes a diverse range of crop rotations and excessive soil tillage. Organic production may be considered a possible solution to the health and environmental problems that result from synthetic chemical inputs, such as fertilizers and pesticides (Aksoy 2001). Many people believe that organic products are healthier than conventionally produced ones and that they are produced in a more environmentally compatible manner (Baade 1985).

In the present investigation, the author gave importance to this fact and applied only naturally obtaining biodegradable waste materials as fertilizers. This helps as in solid waste management, in producing vegetables without dangerous chemical contents and also this kind of fertilizer applications help in the conservation of soil and microorganism.

Sustainable agriculture can be defined as a set of practices that conserve resources and the environment without compromising human needs and the use of organic fertilizers such as animal manure has been indicated as one of its main pillars (Tilman et al. 2002). This review assesses the potential end uses and sustainable market for this organic residue. Processing of kitchen waste material through composting, reduces the environmental risk by transforming the material into safer and more stable product suitable for application to soil (Lazcano et al. 2009) and also reduces the transportation costs. Composted materials are therefore gaining acceptance as organic fertilizers in sustainable agriculture, and there has been a considerable increase in research dedicated to the study of the effects of compost on soil properties and plant growth.

Here the author selected waste materials obtained from kitchen - tea waste, eggshell, onion peel, and vegetable waste materials. All of them were easily available in every home. And to find out the performance of each of its author applied them separately on selected plant.

Food waste can be biodegraded by composting, and reused to fertilize soil. Composting is the aerobic process completed by microorganisms in which the bacteria break down the food waste into simpler organic materials that can then be used in soil. By redistributing nutrients and high microbial populations, compost reduces water runoff and soil erosion by enhancing rainfall penetration, which has been shown to reduce the loss of sediment, nutrients, and pesticide losses to streams by 75% to 95%.

Compost application is a method to maintain soil fertility. It is well known that organic fertilizers increase soil fertility and provide long-term nutrients by gradual decomposition (Angin et al. 2017; Gaiotti et al. 2017; Zhou et al. 2016). Research that investigated the different compost application methods in organic vegetable fields is quite limited. Thus, closer look at this topic is needed to understand how distribution of compost on the field can influence the final yield. From this statement it is clear that it is perfect to select food waste as fertilizers, and those waste materials we were selected can be a better nutrient media for microorganisms and earthworm too.

It is high time that everyone understands the ill effects of using excess chemical fertilizers and take initiatives for reducing the use of chemical fertilizer and pesticides substituting it with other organic amendments like organic manures which not only provides essential nutrients to the plants but also maintains the soil health for the subsequent crops. The over-use of chemical fertilizers can lead to soil acidification and soil crust thereby reducing organic matter content, humus content, beneficial organisms, stunting plant growth, can change the soil pH, increase pests, and even contribute to the release of greenhouse gases. The soil acidity diminishes phosphate intake by crops, increases the toxic ion concentration in the soil, and inhibits crop growth.

'Organic agriculture' is the only solution to nurture the land and to regenerate the soil by going back to our traditional method of farming i.e., free from chemicals, pesticides and fertilizers. This is a possible step for sustainable development by choosing not to use chemicals, synthetic materials, pesticides and growth hormones to produce high nutritional quality food and in adequate quantities. Organically grown food and food products are believed to meet these demands (Rembialkowska 2007). In recent years, organic farming as a cultivation process is gaining increasing popularity (Dangour et al. 2010)

Composts are produced during the process of the decomposition of organic matter by microorganisms in the presence of oxygen. In general, the use of compost maintains and enhances stability and fertility of the agricultural soil (Angin et al. 2017; Zhou et al. 2016). Composts can have direct effects against disease, as well as stimulation of the competing microorganisms and also development of resistance in plants against diseases (Ebrahimi et al. 2018; Carrera et al. 2007). Organic matter is also an important source of energy for bacteria, fungi, and earthworms (Montemurro et al. 2005; Davis, Wilson 2005).

Food and agriculture industry are among the oldest of human practices, but as a source of wastes it does not make any exception from other industrial activities. In the near future the management of food and agricultural wastes will play an important role in the conservation of the natural resources in many countries.

One of the most effective methods to neutralize the adverse effects of waste and other plant residues is to separately collect the waste materials, and convert them into compost, to be reused as organic fertilizer and soil conditioner on farmlands (Vogtmann, Fricke 1988; Fricke, Vogtmann 1994; von Fragstein, Schmidt 1999; Olowoake et al. 2018). Studies revealed the effect of municipal compost on increasing the amount of micronutrients in the soil (Zheljazkov, Warman 2004).

The selected bio manures are easily available organic waste materials in kitchen including tea waste, onion peel, egg shell and kitchen waste mixture were collected separately. Grow bag farming represents a proactive thinking approach that aims to ensure the conservation of land resource.

The current study was conducted to find the best bio manures among the selected ones for the growth and fruit production in tomato. Tomato (*Lycopersicon esculentum*) is an annual plant and one of the most important crops worldwide. This plant grows in almost all types of soil. Most of the tomato producers use both organic fertilizers and traditional methods, though reports suggest that the quality of the fertilizers can have an adverse effect on the tomato quality (Ghorbani et al. 2008). Present study deals with the influence of using kitchen waste compost on *Lycopersicon esculentum* physical growth parameters. Result showed that kitchen waste compost has good potential to improve the physical growth of tomato plants.

Selected easily available organic waste materials in kitchen including tea waste, onion peel, egg shell and kitchen waste mixtures. Tea waste along with soil was one of the prominent items, collected and stored in a bucket and it turned in to a source of earthworm, which named as TwS. The next one was onion peel and soil named as OnS .The third one was eggshell and soil named as EsS , and the fourth one was of kitchen waste mixture and soil named as KwS.

Compost is a good resource to release nutrients during growing season (Abbasi et al. 2002), and to ensure a sustainable and healthy production of tomato. Erhart et al. (2005) reported an increase of yield up to 10% for compost treatments as compared to the control in wheat, barley, and potato for 10 years. They also reported that yield response to compost amendment was increased over time. Furthermore, Mehdizadeh et al. (2013) have also illustrated that tomato fruit yield has been increased by 94% in comparison with control. Similar results were reported by Angin et al. (2017). However, applying nutrients have different effects on soil microbes and plant communities. Studies show that Nitrogen fertilizers can suppress soil microorganisms (Geisseler, Scow 2014).

When comparing the effect of different treatment, TwS gave good response in yield and growth to the plant. Along with this it improves the soil quality. Tea waste management can be done in an excellent way by converting it into a source of vermin culture.

The superiority of the treatment may be due to the fact that it might have taken advantage of the merits conferred by both vermicompost and chemical fertilizer in a most poised condition. As suggested by Srivastava et al. (2012), the integrated application of vermicompost and mineral fertilizer in appropriate ratio resulted in more balanced nutrient contents, microbial population and organic manure. This might have led to increased uptake of essential nutrients which in turn resulted in increased vegetative growth of the plant to help for better carbohydrate build up that subsequently contributed to higher fruit yield and quality components (Suge et al. 2011). Moreover, as Namazi et al. (2015) elaborated, adding vermicompost to the soil not only increased the nutritious elements needed for the plant but also improved the soil environment, encouraging the proliferation of roots to draw more water and nutrients from larger areas, finally resulting in improved biological function of the plant. Tea waste is available in every Indian home irrespective of being urban or rural. Therefore it can be selected as an ideal bio manures obtained from kitchen for sustainable organic farming.

Tomato is one of the most accepted vegetables worldwide, and contains carbohydrates, amino acids, minerals, and vitamins. Yield and nutrient content of tomato are noticeably exaggerated by the application of inorganic fertilizer (Dumas et al. 2003). In fact, non-judicious use of inorganic fertilizer may lead to environmental pollution including contamination of groundwater, and soil acidification as well as increase denitrification resulting in higher the emission of nitrous oxide (N2O) to the atmosphere which is accountable for global warming. Currents efforts include exploring the possibility of substitution of inorganic fertilizer with organic ones which are eco-friendly and cost effective. Taiwo et al. (2007) recommended that organic fertilizer can be combined with inorganic fertilizer at rates below those recommended for sustainable tomato production.

Compost used to enhance soil bodily and organic matter, water retention capability, drainage, pH, better availability of soil micro- organism and decreasing the negative impact of chemical based totally insecticides and fertilizers within the ecosystems (Chaudhary, Mishra, 2018). The compost is fundamentally centred around nitrogen, phosphorous, potassium and different micronutrients that can be very much utilized as a soil conditioner.

Composting is the process by which complex organic materials are changed into a material with environmentally useful applications. The composting can transform huge quantities of organic material into compost in a relatively short period by properly organising moisture, air and nutrients. During composting, the microorganism consumes oxygen and nourish on organic matter. Active composting generates a significant amount of heat and large quantities of carbon dioxide and water vapour are

released into the air.

Treatment comprising kitchen waste compost and organic content of soil showed significant effects on vegetative growth such as Plant height, Number of leaves, flowers and fruits and tomato yield. Morphologically, both qualitative and quantitative characters of the *Lycopersicon esculentum* had shown great variation in different kitchen wastes when compared to the control. Use of compost as a fertilizer has enhanced the physical structure of the soil that incorporates gardening soil mixture. Moreover there was an expanded concealment of plant maladies brought about by soil-borne nematodes, growths and microorganisms because of the expansion of compost to the soil in different cropping pattern. Kostov et al. (1996) directed a test by treating the soil with compost, mineral composts and manure to study the yield efficiency and quality of vegetables and fruits. From the above study, it is concluded that kitchen waste compost has good potential to enhance the physical parameters of plants.

Leaf variation in colour, length and shapes were also observed in different kitchen waste treatment. Application of egg shell for the tomato plant attained a maximum height (123 cm. to 127 cm.) but the fruit production 28 to 35 numbers per plant was observed in the application of tea waste as a bio fertilizer. Flowering is an important phase in plant development as the plants are vulnerable to environmental stress. It is the stage of plant development that determines when vegetables are ripe for harvest.

Fruits were healthy and oval in shape and large in size. Oval shaped fruits and small in size fruits were in the case of plants grown in control and kitchen waste mixture. Round large fruits were observed in plants grown in onion peel and round medium sized fruits were resulted in plants grown in egg shell. A maximum number of 4 to 10 fruits only attain maturity in the case of control. While the other treatment with 16 to 20 per fruits in the case of egg shells, plants in onion peel application had shown a range of 12 to 15 fruits and the same number of fruits per plant were 8 to 13 in the case of kitchen mixture.

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Soil test analysis result was compared on the characters like pH, amount of organic carbon, phosphorous and potassium present in different kitchen waste in potting mixture and without kitchen waste (Control) was possible. An alkaline nature of the soil (pH - 7.80) met in the potting mixture with kitchen waste mixture. A value of pH - 6.80 near to neutral value (7.0) was found in potting mixture added with onion peel.

All except kitchen waste mixture were acidic in nature. Highest values of organic carbon (1.98 %), phosphorous (35 Kg/ha) and potassium (400 Kg/ha) were found in potting mixture added with tea waste. Two lowest values for organic carbon was recorded in potting mixture added with onion peel (0.88 %) and control (1.08 %). Total suspended solid (TSS) or non-filterable solids was absent in all the soil samples except in potting mixture applied with egg shell (0.200).

Besides the ecological concerns, the rising cost of chemical fertilizers coupled with the low affordability to small holder farmers have led to growing interests among the scientific and farming community to shift their attention from chemical alone agriculture to integrated nutrient management strategy which utilizes both organic and inorganic nutrient forms (Singh et al. 2010). The best results were observed in the case of each kitchen waste when separately applied in the potting mixture compared to the application of kitchen waste mixture and control.

These findings were in agreement with the reports of Prativa, Bhattarai (2011) and Chatterjee (2013) who noted maximum number of fruit clusters in treatments receiving 75% of NPK combined with higher amount of organic manure including vermicompost. They considered the increased uptake of NPK due to the solubilisation effect of plant nutrients by the addition of vermicompost and farm yard manure. This reaffirms the significance of the integrated use of vermicompost and inorganic fertilizers in enhancing the performance of tomato over the individual nutrient sources. Several researchers (Azarmi et al. 2008; Nada et al. 2011) who reported the significant increase in soil micronutrients after vermicompost application support the finding of the present study.

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