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INFLUENCE OF KITCHEN WASTE COMPOST AND CHEMICAL FERTILIZER ON THE GROWTH AND YIELD OF TOMATO (*Solanum lycopersicum*)

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Abstract

A pot experiment was conducted to evaluate the effect of kitchen waste compost (KWC) and NPK fertilizers on the growth and yield of tomato. It was laid out in a completely randomized block design (CRBD) using 25 treatments having 3 replications each. Agronomic parameters of the growth and yield of tomato were recorded at 15, 30, 45, and 60 days interval. The highest growth and yield parameter found with 60 days. The tallest plant height (57 cm) was recorded in T_{13}($N_{120}P_{60}K_{80}$ kg ha^{-1} + 2.5ton KWC ha^{-1}). Highest number of leaf found (17 per plant) in T_{18} ($N_{30}P_{15}K_{20}$ kg ha^{-1} + 7.5 ton KWC ha^{-1}) and T_{23} ($N_{60}P_{30}K_{40}$ kg ha^{-1} + 10 ton KWC ha^{1}. The length of midrib (22 cm) inT_3 (5ton KWC ha^{-1}) and dry weight of midrib (1.46 g $plant^{-1}$) obtained topmost in T_6($N_{30}P_{15}K_{20}$ kg ha^{-1}). The girth of plants (1.4 cm) in T_{14}: ($N_{30}P_{15}K_{20}$ kg ha^{-1} + 5 ton KWC ha^{-1}, and leaf area (5.61 cm^2) in T_2 (2.5 ton KWC ha^{-1}). Total fresh weight of leaf, root and stem (60.3 g $plant^{1}$) and dry weight of leaf, root and stem (21.91 g $plant^{-1}$) were superior inT_{24}($N_{90}P_{45}K_{60}$ kg ha^{-1} + 10 ton KWC ha^{-1}), number of fruit per plant (10) inT_5(10 ton KWC ha^{-1}) and longest fruit (7.5 cm) inT_5(10 ton KWC ha^{-1}). Maximum fresh weight of tomato fruit (13.48 g $plant^{-1}$) produces in T_{24} ($N_{90}P_{45}K_{60}$ kg ha^{-1} + 10 ton KWC ha^{-}1) and dry weight (5.32 g $plant^{-1}$) in T_{20} ($N_{90}P_{45}K_{60}$ kg ha^{-1} + 7.5 ton KWC ha^{-1}). The findings revealed that KWC with NPK T_{24} ($N_{90}P_{45}K_{60}$ kg ha^{-1} + 10 ton KWC ha^{-1}) could be suggested to use for the maximum growth and yield of tomato. This trial has also been created the evidence that kitchen waste may be an alternative source of organic materials to produce tomato.

***Key words*:** Growth and yield; Kitchen waste compost; NPK fertilizers; Tomato.

INTRODUCTION

Tomato is the second most important vegetable in terms of production, consumption and economic importance in the world (Ibitoye *et al*. 2009, Zaccone *et al*. 2010). It is originated in Western South America and Central America. Tomatoes are a good source of vitamin A and C. The fruits are commonly eaten raw in salads, served as a cooked vegetable, used as an ingredient of various prepared dishes, and pickles. A large percentage of the world's tomato crop is used for processing products including canned tomatoes, tomato juice, ketchup, paste and sun-dried tomatoes. The water content of tomatoes is around 95%. The other 5% consists of mainly carbohydrates and fiber. The nutrients found in a small (100g) raw tomato are- calories 18, water 95%, protein 0.9 g, carbs 3.9 g, sugar 2.6 g, fiber 1.2 g and fat 0.2 g.

The production of tomato in Bangladesh is increasing day by day due to recent demand of consumers in the country. There has been developed 10 high yielding varieties of tomato by Bangladesh Agricultural Research Institute (BARI), *viz.* Ratan, Manik, BARI Tomato-3, BARI Tomato-4, BARI Tomato-5, Chaiti, Apurba, Shila, Lalima and Anupama. The BARI Tomato-4, BARI Tomato-5, Chaiti, Lalima and Anupama (hybrid) can also be grown in warm season. These varieties of tomato need to cultivate under organic agriculture due to the benefits of human health, environment and biodiversity, market preferring, safety from pesticides, better tasty fruit with higher nutrient content (Gąstoł *et al*. 2011). The organic agriculture has been suggested as an alternative to conventional agriculture and today up to 8% of agricultural areas in some European countries are managed organically (Drinkwater *et al*. 1998, Wood *et al*. 2006). The Organic farming has improved the soil structure and stability, higher yields and especially crop quality (Chang *et al*. 2013, Marzouk and Kassem 2011, Bhardwaj *et al*. 2011).

In Bangladesh there are scarcity of traditional organic sources such as cow dung, dead leaves, straw, weeds, water hyacinth, household wastes like non-edible food, fruit and vegetable parts, after-meal wastes, saw dust and rice husk *etc.*; these are being used as fodder and kitchen fuel in rural areas. As a result, the use of organic manure is becoming lower rate and sometimes little or no use of green manure causing the depletion of soils (Bhardwaj *et al*. 2011). Research on organic farming for vegetable crops is increasing every year in Bangladesh (Haque *et al*. 2020, Shushupti *et al*. 2021, Rikza *et al*. 2021, Zaman *et al*. 2021).

In this condition alternative sources of organic materials, viz: kitchen wastage, municipal garbage, wastes of leather factory, sugar mill bagasse, *etc*. could be used. There is a huge accumulation of kitchen wastage in the country. Kitchen waste is one kind of solid waste which is produced from the kitchen during the time of preparing and processing of food that makes a large portion (50-60%) of the total solid waste generated in Bangladesh (Rahman and Ali 2000). These organic substances are bulky to handle and contribute to numerous liquid and gaseous emissions that deteriorate dumpsite environments.

The kitchen waste generation rate was 0.41 kg/capita/day in the urban area of Bangladesh, while waste collection efficiency varied from 37 to 77% with an average of 55% (Rahman and Ali 2000). Huge amount of uncollected wastes, a high proportion of which are organic, creates nuisance and pollutes the local environment rapidly that needs appropriate treatment (Bahauddin and Uddin 2012). The compost of kitchen waste contained considerable amount of plant nutrients viz. C (27.89%), N (1.12%), C/N ratio 21.90, P (10.23%), K (7.32%)and Ca (0.52%)and support plant growth and yield (Sulok *et al*.2021). This finished product of kitchen waste compost is used in landscaping, horticulture and agriculture as a soil conditioner and fertilizer due to its high carbon and nitrogen content (Sambali and Mehrotra 2009).

So, it is high time to use the kitchen wastage in agricultural production to rescue the environment and produce quality food. But, there are possibilities of exploitation in higher crop production due to the sole use of kitchen waste, as earlier worker Guichard *et al.* (2001) reported that organic farming comes together with higher costs and lower yield disadvantages for the farmers. This difficulty may overcome by the agricultural scientists who are engaged to establish agricultural systems with lower production cost and conserving the natural resources (Munir *et al*. 2007). In this situation, the high production cost of crop and low yield due to sole organic fertilizer application are great problem; these can be overcome with the combined use of kitchen wastage and chemical fertilizer (Guichard *et al.* 2001). A little information is available in the literature on the cultivation of tomato (Saha *et al*. 2017, Saha *et al*. 2020) using kitchen waste compost and chemical fertilizer under the climatic conditions of Bangladesh. Considering the above facts, this study was conducted to evaluate the effects of kitchen waste compost and NPK fertilizers on the growth and yield of tomato plants grown in soil in the net house of the department of Soil, Water and Environment, University of Dhaka.

MATERIAL AND METHODS

Soil sample collection and characterization

Agricultural soil sample (0-15 cm depth) was collected from Araihazar upazila under Narayanganj district. The sample was air-dried, ground and sieved through a 2 mm sieve. It was characterized as per the location specific guide line described in FRG, 2018 of BARC. The sample area was under AEZ 16: Middle Meghna River Floodplain. The soils of the area were grey, loamy on the ridges and grey to dark grey clays in the basins. Grey sands to loamy sands with compact salty topsoil occupy the areas of Old Brahmaputra char. Dominant general soil type is non-calcareous grey floodplain soils. Top soils are very strongly acidic to neutral in medium low and low land soils, and the sub-soils are slightly acidic to slightly alkaline. General fertility level is medium with very low to low in nitrogen and low to medium in organic matter contents. Phosphorus and zinc levels are low to medium and boron level is very low to medium (BARC 2018).

Preparation of kitchen waste compost (KWC)

Ingredients were collected from the kitchen of Dr. Muhammad Shahidullah Hall, University of Dhaka and Rajshahi town. These were cut into small pieces and placed in a plastic drum. Two hundred grams of garden soil were added to hasten decomposition process. Ingredients were covered with a perforated lid of the drum. A small quantity of water was added to moisten the samples as and when needed. Addition of small quantities of urea and triple superphosphate hastens the rotting of raw materials which decomposes very slowly (BARC 2018). Finally, complete decomposed samples (after 3 months) were air-dried, sun-dried and ground. Generally compost (urban) contents contain 1.5, 0.6 and 1.5 per cent N, P and K, respectively (BARC 2018).

Pot experiment

Six kilograms of soil were taken in each earthen pot (22.5 cm diameter × 18 cm depth). The pots were arranged in a completely randomized block design (CRBD). Twenty five treatments with three replicates each were: T_1: Control (-KWC and -NPK), T_2: 2.5 ton kitchen compost (KWC) ha^{-1},T_3: 5 ton KWC ha^{-1}, T_4: 7.5 ton KWC ha^{-1}, T_5: 10 ton KWC ha^{-1},T_6: $N_{30}P_{15}K_{20}$ kg ha^{-1} ,T_7: $N_{60}P_{30}K_{40}$ kg ha^{-1} , T_8: $N_{90}P_{45}K_{60}$ kg ha^{-1},T_9: $N_{120}P_{60}K_{80}$ kg ha^{-1},T_{10}: $N_{30}P_{15}K_{20}$ kg ha^{-1} + 2.5 ton KWC ha^{-1}, T_{11}: $N_{60}P_{30}K_{40}$ kgha^{-1} + 2,5 ton KWC ha^{-1}, T_{12}: $N_{90}P_{45}K_{60}$ kg ha^{-1} + 2.5 ton KWC ha^{-1}, T_{13}: $N_{120}P_{60}K_{80}$ kg ha^{-1} + 2.5 ton KWC ha^{-1}, T_{14}: $N_{30}P_{15}K_{20}$ kg ha^{-1} + 5 ton KWC ha^{-1}, T_{15}: $N_{60}P_{30}K_{40}$ kg ha^{-1} + 5 ton KWC ha^{-1}, T_{16}: $N_{90}P_{45}K_{60}$ kg ha^{-1} + 5 ton KWC ha^{-1}, T_{17}: $N_{120}P_{60}K_{80}$ kgha^{-1}+ 5 ton KWC ha^{-1}, T_{18}: $N_{30}P_{15}K_{20}$ kg ha^{-1} + 7.5 ton KWC ha^{-1}, T_{19}: $N_{60}P_{30}K_{40}$ kg ha^{-1} + 7.5 ton KWC ha^{-1}, T_{20}: $N_{90}P_{45}K_{60}$ kg ha^{-1} + 7.5 ton KWC ha^{-1}, T_{21}: $N_{120}P_{60}K_{80}$ kg ha^{-1} + 7.5 ton KWC ha^{-1}, T_{22}: $N_{30}P_{15}K_{20}$ kg ha^{-1} + 10 ton KWC ha^{-1}, T_{23}: $N_{60}P_{30}K_{40}$ kg ha^{-1} + 10 ton KWC $ha^{1,}$ T_{24}: $N_{90}P_{45}K_{60}$ kg ha^{-1} + 10 ton KWC ha^{-1} and T_{25}: $N_{120}P_{60}K_{80}$ kg ha^{-1} + 10 ton KWC ha^{-1}. The seeds of tomato (Lal Teer) were collected from Siddique Bazar, Dhaka. Seedlings were raised in water in a glass shaped plastic container. A three weeks old seedlings were transplanted per pot. Water was applied daily in the morning. Height was measured from the soil base level to the tip of the leaf, and leaf number was counted with the help of a tally counter at 15 days interval. Weeding was done as and when needed.

Harvesting

Two month (60 d) old plants were harvested as leaf, root, stem and fruit. The roots were washed with tap water and finally with distilled water to remove any adhering particles on the root surface. The fresh weight of the samples of different plant parts was recorded. Samples were air-dried in room temperature and finally oven-dried at 65^0C for 48 hours in the laboratory. The dry weight of the samples was recorded. The samples were ground with a mechanical grinder and stored in paper bags for chemical analysis. Results were statistically analyzed using Microsoft Excell 2013, IBM SPSS and Software Minitab 19.

RESULTS AND DISCUSSION

Plant growth

Plant growth was evaluated in terms of plant height and number of leaf (Table 1), midrib, girth of plants and leaf area (Table 2), fresh and dry weight of root, leaf and stem (Table 3) and fresh and dry weight of fruits (Table 4). The tallest plant (57 cm) was observed in T_{13}: $N_{120}P_{60}K_{80}$ kg ha^{-1} + 2.5 ton KWC ha^{-1} (Table 1). But, a spectacular height was observed in T_{14}: $N_{30}P_{15}K_{20}$ kg ha^{-1} + 5 ton KWC ha^{-1} (55 cm) also. The lowest height was found in T_6: $N_{30}P_{15}K_{20}$ kg ha^{-1} (23 cm) and T_1: Control (-KWC and -NPK) (24 cm). This enhanced growth of tomato under this study might be the causes of the improvement of both physical and chemical properties of soil due to addition of the organic wastage, which agrees with Adeoye (2008).

Table 1. Performance of kitchen waste compost (KWC) and chemical fertilizer the on height (cm) and number of leaf per plant at 15d interval.

Treatments	Height (cm)				Number of leaf			
	15d	30d	45d	60d	15d	30d	45d	60d
T_1: Control(-KWC and -NPK)	15^{g}	19^{d}	22^{e}	24^{e}	4^{b}	8^{b}	10^{ab}	13^{abc}
T_2: 2.5 ton KWC ha^{-1}	$17^{abcdefg}$	26^{abcd}	31^{abcde}	36^{abcde}	4^{ab}	8^{ab}	10^{ab}	16^{abc}
T_3: 5 ton KWC ha^{-1}	20^{abcde}	32^{abcd}	43^{abcd}	49^{abcd}	4^{ab}	8^{ab}	11^{ab}	16^{ab}
T_4: 7.5 ton KWC ha^{-1}	18^{fg}	24^{fg}	31^{de}	35^{de}	4^{b}	10^{ab}	12^{ab}	16^{abc}
T_5: 10 ton KWC ha^{-1}	18^{cdefg}	27^{abcd}	35^{abcde}	40^{abcde}	4^{ab}	10^{ab}	14^{ab}	15^{ab}
T_6: $N_{30}P_{15}K_{20}$kg ha^{-1}	11^{defg}	16^{defg}	20^{bcde}	23^{bcde}	4^{ab}	8^{b}	10^{ab}	14^{abc}
T_7: $N_{60}P_{30}K_{40}$kg ha^{-1}	20^{abcdef}	27^{abcd}	32^{bcde}	36^{bcde}	4^{ab}	10^{ab}	13^{ab}	14^{bc}
T_8: $N_{90}P_{45}K_{60}$kg ha^{-1}	19^{efg}	29^{efg}	37^{cde}	42^{cde}	4^{ab}	8^{ab}	10^{ab}	15^{abc}
T_9: $N_{120}P_{60}K_{80}$kg ha^{-1}	15^{fg}	24^{fg}	30^{bcde}	34^{bcde}	4^{ab}	8^{ab}	10^{ab}	14^{abc}
T_{10}: $N_{30}P_{15}K_{20}$ kg ha^{-1} + 2.5 ton KWC ha^{-1}	20^{bcdefg}	30^{abcd}	37^{bcde}	41^{abcde}	4^{ab}	8^{b}	10^{ab}	15^{abc}
T_{11}: $N_{60}P_{30}K_{40}$ kg ha^{-1} + 2,5 ton KWC ha^{-1}	21^{efg}	33^{abcd}	41^{abcde}	46^{abcde}	4^{ab}	6^{b}	10^{ab}	15^{bc}
T_{12}: $N_{90}P_{45}K_{60}$ kg ha^{-1} + 2.5 ton KWC ha^{-1}	20^{bcdefg}	29^{abcd}	34^{abcde}	38^{abcde}	4^{ab}	6^{b}	8^{b}	16^{abc}
T_{13}: $N_{120}P_{60}K_{80}$ kg ha^{-1} + 2.5 ton KWC ha^{-1}	22^{ab}	39^{ab}	51^{ab}	57^{ab}	2^{ab}	8^{b}	12^{ab}	16^{bc}
T_{14}: $N_{30}P_{15}K_{20}$ kg ha^{-1} + 5 ton KWC ha^{-1}	22^{a}	38^{a}	50^{a}	55^{a}	4^{ab}	8^{ab}	14^{ab}	16^{abc}
T_{15}: $N_{60}P_{30}K_{40}$ kg ha^{-1} + 5 ton KWC ha^{-1}	22^{abc}	34^{abcd}	42^{abcd}	46^{abcd}	5^{a}	10^{ab}	12^{ab}	13^{c}
T_{16}: $N_{90}P_{45}K_{60}$ kg ha^{-1} + 5 ton KWC ha^{-1}	20^{cdefg}	31^{abcd}	39^{abcde}	43^{abcde}	4^{ab}	8^{ab}	12^{ab}	16^{abc}
T_{17}: $N_{120}P_{60}K_{80}$ kg ha^{-1} + 5 ton KWC ha^{-1}	22^{abcd}	34^{abcd}	44^{abcde}	48^{abcd}	2^{ab}	6^{ab}	8^{ab}	14^{c}
T_{18}: $N_{30}P_{15}K_{20}$ kg ha^{-1} + 7.5 ton KWC ha^{-1}	16^{defg}	25^{abcd}	37^{abcd}	40^{abcd}	4^{ab}	12^{ab}	15^{ab}	17^{abc}
T_{19}: $N_{60}P_{30}K_{40}$ kg ha^{-1} + 7.5 ton KWC ha^{-1}	21^{abc}	32^{abcd}	40^{abcd}	44^{abcd}	4^{ab}	10^{a}	12^{a}	14^{abc}
T_{20}: $N_{90}P_{45}K_{60}$ kg ha^{-1} + 7.5 ton KWC ha^{-1}	$18^{abcdefg}$	31^{abcd}	39^{abcde}	44^{abcde}	4^{ab}	11^{ab}	10^{ab}	14^{abc}
T_{21}: $N_{120}P_{60}K_{80}$ kg ha^{-1} + 7.5 ton KWC ha^{-1}	18^{abc}	29^{abc}	39^{adcd}	45^{abcd}	4^{ab}	10^{ab}	14^{ab}	15^{abc}
T_{22}: $N_{30}P_{15}K_{20}$ kg ha^{-1} + 10 ton KWC ha^{-1}	21^{a}	35^{ab}	43^{abc}	48^{abc}	4^{ab}	10^{a}	10^{ab}	14^{abc}
T_{23}: $N_{60}P_{30}K_{40}$ kg ha^{-1} + 10 ton KWC ha^{-1}	20^{efg}	31^{efg}	38^{abcde}	42^{abcde}	4^{ab}	11^{a}	14^{ab}	17^{a}
T_{24}: $N_{90}P_{45}K_{60}$ kg ha^{-1} + 10 ton KWC ha^{-1}	17^{efg}	26^{efg}	35^{abcde}	40^{abcde}	2^{ab}	10^{a}	10^{ab}	15^{abc}
T_{25}: $N_{120}P_{60}K_{80}$ kg ha^{-1} + 10 ton KWC ha^{-1}	17^{cdefg}	22^{cdefg}	31^{abcde}	35^{abcde}	4^{ab}	8^{ab}	10^{ab}	16^{abc}

^{abcdefghi} Data bearing different superscripts within the same column differ significantly at 5% level.

The highest number of leaf (17 per plant) was achieved in T_{18}: $N_{30}P_{15}K_{20}$ kg ha^{-1} + 7.5 ton KC ha^{-1} and in T_{23}: $N_{60}P_{30}K_{40}$ kg ha^{-1} + 10 ton KWC ha^{-1} treatments at harvest (60d). The lowest number of leaf (13 per plant) was observed inT_1: Control (-KWC and -NPK) (Table 1). Rahman and Akter (2019) found similar results on the production of capsicum while kitchen waste compost and vermicompost incorporated to soil in combination with chemical fertilizer.

Midrib, girth and leaf area

Midrib is the main or central vein of a leaf from which arise the secondary or lateral veins. Midrib helps the leaf to keep in an upright position, and it also helps to keep the leaf strong during the wind. It also supports the leaf in such a way that it can to make it stand and expose it to proper sunlight. The longest midrib was found (22 cm) in T_3: 5 ton KWC ha^{-1}and highest dry weight of midrib was 3.3 g plant^{-1} in T_8: $N_{90}P_{45}K_{60}$kgha^{-1} (Table 2). The highest girth (1.4 cm) of plants was recorded in T_{14}: $N_{30}P_{15}K_{20}$ kg ha^{-1} + 5 ton KWC ha^{-1} .The shortest length (6 cm) of midrib was observed in T_{18}: $N_{30}P_{15}K_{20}$ kg ha^{-1} + 7.5 ton KWC ha^{-1} and the lowest dry weight of midrib (0.02 g plant^{-1}) was observed in T_{16}: $N_{90}P_{45}K_{60}$ kg ha^{-1} + 5 ton KWC ha^{-1} treatment. The highest leaf area (5.61 cm^2) was found in T_2: 2.5 ton KWC ha^{-1} and the lowest leaf area (3.87 cm^2) were recorded in T_{16}: $N_{90}P_{45}K_{60}$ kg ha^{-1} + 5 ton KWC ha^{-1}. Patil *et al*. (2004) reported the maximum midrib, girth and leaf area of tomato achieved with the combined application of inorganic and other organic materials.

Table 2. Influence of kitchen waste compost and chemical fertilizer on the length and dry weight of midrib, girth of plant and leaf area at harvest.

Treatments	Length of midrib (cm)	Dry weight of midrib (g plant^{-1})	Girth of plant (cm)	Leaf area (cm^2)
T_1: Control (-KWC&-NPK)	15.5^{bcde}	0.54^{cdefg}	0.8^{efg}	4.13^{f}
T_2: 2.5 ton KWC ha^{-1}	20.0^{ab}	1.09^{bcdef}	0.9^{cde}	5.61^{ab}
T_3: 5 ton KWC ha^{-1}	22.0^{a}	1.17^{b}	1.3^{bc}	5.51^{a}
T_4: 7.5 ton KWC ha^{-1}	14.0^{bcde}	0.53^{defg}	0.9^{efg}	4.92^{cde}
T_5: 10 ton KWC ha^{-1}	20.0^{abc}	1.43^{bcde}	1.0^{defg}	4.87^{cdef}
T_6: $N_{30}P_{15}K_{20}$kg ha^{-1}	21.0^{abc}	1.46^{bcdef}	0.9^{efg}	4.22^{ef}
T_7: $N_{60}P_{30}K_{40}$kg ha^{-1}	20.0^{abc}	1.17^{cdefg}	0.7^{g}	4.74^{cde}
T_8: $N_{90}P_{45}K_{60}$kg ha^{-1}	11.5^{cde}	3.3^{a}	0.7^{fg}	4.35^{cde}
T_9: $N_{120}P_{60}K_{80}$kg	11.0^{de}	0.32^{cdefg}	0.8^{efg}	4.55^{ef}
T_{10}: $N_{30}P_{15}K_{20}$ kg ha^{-1} + 2.5 ton KWC ha^{-1}	10.0^{cde}	0.18^{fg}	0.8^{defg}	4.15^{def}
T_{11}: $N_{60}P_{30}K_{40}$ kg ha^{-1} + 2.5 ton KWC ha^{-1}	7.00^{cde}	0.08^{efg}	0.7^{g}	4.38^{ef}
T_{12}: $N_{90}P_{45}K_{60}$ kg ha^{-1} + 2.5 ton KWC ha^{-1}	18.0^{bcde}	0.73^{cdefg}	0.8^{g}	4.65^{def}
T_{13}: $N_{120}P_{60}K_{80}$ kg ha^{-1} + 2.5 ton KWC ha^{-1}	17.0^{bcde}	1.8^{bcd}	0.8^{cde}	4.75^{bcd}
T_{14}: $N_{30}P_{15}K_{20}$ kg ha^{-1} + 5 ton KWC ha^{-1}	17.0^{abc}	0.91^{cdefg}	1.4^{a}	5.21^{abc}
T_{15}: $N_{60}P_{30}K_{40}$ kg ha^{-1} + 5 ton KWC ha^{-1}	17.0^{abc}	0.55^{cdefg}	1.1^{bcd}	4.66^{def}
T_{16}: $N_{90}P_{45}K_{60}$ kg ha^{-1} + 5 ton KWC ha^{-1}	8.00^{e}	0.016^{g}	1^{cde}	3.87^{g}
T_{17}: $N_{120}P_{60}K_{80}$ kg $^{ha-1}$ + 5 ton KWC ha^{-1}	15.0^{abc}	0.69^{cdefg}	1.0^{bcd}	4.41^{def}
T_{18}: $N_{30}P_{15}K_{20}$ kg ha^{-1} + 7.5 ton KWC ha^{-1}	6.00^{cde}	0.12^{fg}	1.1^{abc}	4.75^{cdef}
T_{19}: $N_{60}P_{30}K_{40}$ kg ha^{-1} + 7.5 ton KWC ha^{-1}	15.0^{bcde}	1.06^{bcdefg}	1.1^{abc}	4.96^{def}
T_{20}: $N_{90}P_{45}K_{60}$ kg ha^{-1} + 7.5 ton KWC ha^{-1}	14.0^{bcde}	0.76^{cdefg}	0.9^{efg}	4.61^{cdef}
T_{21}: $N_{120}P_{60}K_{80}$ kg ha^{-1} + 7.5 ton KWC ha^{-1}	14.0^{abcd}	0.78^{bcdef}	1.1^{bc}	4.73^{def}
T_{22}: $N_{30}P_{15}K_{20}$ Kg ha^{-1} + 10 ton KWC ha^{-1}	16.0^{abc}	0.63^{bcdefg}	1.2^{ab}	4.55^{cde}
T_{23}: $N_{60}P_{30}K_{40}$ kg ha^{-1} + 10 ton KWC ha^{-1}	17.0^{bcd}	1.06^{bcdefg}	0.8^{defg}	4.23^{defg}
T_{24}: $N_{90}P_{45}K_{60}$ kg ha^{-1} + 10 ton KWC ha^{-1}	13.0^{abc}	0.49^{cdefg}	1.0^{cdef}	4.35^{cdef}
T_{25}: $N_{120}P_{60}K_{80}$ kg ha^{-1} + 10 ton KWC ha^{-1}	10.0^{cde}	0.89^{bc}	0.8^{efg}	4.61^{efg}

^{abcdefghi} Data bearing different superscripts within the same column differ significantly at 5% level.

Biomass production

Plants were harvested as leaf, root and stem (Table 3). The values differed significantly ($p<0.05$). The highest fresh weight of leaf (40.65 g plant^{-1}) was measured in T_{24}: $N_{90}P_{45}K_{60}$ kg ha^{-1} + 10 ton KWC ha^{-1}, highest weight of root (5.29 g plant^{-1}) was recorded in T_3: 5 ton KWC ha^{-1} treatment, and highest weight of stem (32.31 g plant^{-1}) achieved in T_8: $N_{90}P_{45}K_{60}$kg ha^{-1} treatment. The highest total fresh weight of leaf, root and stem (51.7 g plant^{-1}) was observed in T_6: $N_{30}P_{15}K_{20}$kg ha^{-1}. The highest dry weight of leaf (3.58 g plant^{-1}) was found in T_3: 5 ton KWC ha^{-1} treatment, highest dry weight of root (3.24 g plant^{-1}) was recorded in T_{14}: $N_{30}P_{15}K_{20}$ kg ha^{-1} + 5 ton KWC ha^{-1} treatment, and highest dry weight of stem (11.69 g plant^{-1}) was obtained in T_7: $N_{60}P_{30}K_{40}$kg ha^{-1} treatment. The highest total dry weight of leaf, root and stem (21.91 g plant^{-1}) was observed in T_{24}: $N_{90}P_{45}K_{60}$ kg ha^{-1} + 10 ton KWC ha^{-1}.

On the other hand, the lowest fresh weight of leaf (0.7 g plant^{-1}) was found in T_{25}: $N_{120}P_{60}K_{80}$ kg ha^{-1} + 10 ton KWC ha^{-1} treatment, the lowest weight of root (0.86 g plant^{-1}) was recorded in T_8: $N_{90}P_{45}K_{60}$ kg ha^{-1} treatment, and the lowest weight of stem (6.89 g plant^{-1}) was achieved in T_{11}: $N_{60}P_{30}K_{40}$kg ha^{-1} + 2.5 ton KWC ha^{-1} treatment. The lowest total fresh weight of leaf, root and stem (11.16 g plant^{-1}) in T_{11}: $N_{60}P_{30}K_{40}$kg ha^{-1} + 2.5 ton KWC ha^{-1}. The lowest dry weight of leaf (0.4 g plant^{-1}) was obtained in T_{25}: $N_{120}P_{60}K_{80}$ kg ha^{-1} + 10 ton KWC ha^{-1} treatment, lowest dry weight of root (0.15 g plant^{-1}) was found in T_1: Control treatment, and lowest dry weight of stem (5.63 g plant^{-1}) was recorded inT_{11}: $N_{60}P_{30}K_{40}$kg ha^{-1} + 2.5 ton KWC ha^{-1}. The lowest total dry weight of leaf, root and stem (5.63 g plant^{-1}) was obtained in T_{11}: $N_{60}P_{30}K_{40}$kg ha^{-1} + 2.5 ton KWC ha^{-1}.

Table 3. Effects of kitchen waste compost and chemical fertilizer on fresh and dry weight of leaf, root and stem.

Treatments	Fresh weight (g plant^{-1})				Dry weight (g plant^{-1})			
	Leaf	Root	Stem	Total	Leaf	Root	Stem	Total
T_1: Control (-KWC and -NPK)	3.68^{c}	2.46^{bcde}	12.7^{bcde}	18.84^{bcd}	1.09^{bc}	0.15^{cd}	9.66^{ab}	10.9^{abcd}
T_2: 2.5 ton KWC ha^{-1}	9.11^{bc}	2.51^{bcde}	17.83^{abcde}	29.45^{abcd}	2.85^{bc}	0.92^{bcd}	8.19^{abcd}	11.96^{abcd}
T_3: 5 ton KWC ha^{-1}	17.27^{ab}	5.29^{ab}	24.16^{abcde}	46.72^{a}	3.58^{ab}	1.78^{bcd}	11.14^{abcd}	16.17^{ab}
T_4: 7.5 ton KWC ha^{-1}	8.05^{bc}	2.78^{bcde}	22.47^{abcde}	33.3^{abcd}	2.32^{bc}	1.52^{abcd}	10.58^{abc}	14.42^{abc}
T_5: 10 ton KWC ha^{-1}	19.05^{abc}	2.78^{abcd}	24.48^{a}	46.31^{a}	4.58^{abc}	1.82^{abc}	6.71^{abcd}	13.11^{ab}
T_6: $N_{30}P_{15}K_{20}$kg ha^{-1}	17.89^{bc}	2.67^{bcde}	30.51^{abcde}	51.07^{abcd}	4.68^{abc}	0.57^{d}	11.97^{abcd}	17.22^{abc}
T_7: $N_{60}P_{30}K_{40}$kg ha^{-1}	6.8^{c}	2.44^{abcde}	28.31^{abcd}	37.55^{abcd}	1.41^{bc}	1.61^{bcd}	11.69^{abc}	14.71^{abcd}
T_8: $N_{90}P_{45}K_{60}$kg ha^{-1}	2.11^{c}	0.86^{de}	32.31^{a}	35.28^{abc}	0.26^{bc}	0.55^{bcd}	11.77^{ab}	12.58^{abc}
T_9: $N_{120}P_{60}K_{80}$kg ha^{-1}	2.01^{c}	2.74^{cde}	14.15^{cde}	18.90^{bcd}	0.23^{c}	0.74^{bcd}	7.82^{abcd}	8.79^{bcd}
T_{10}: $N_{30}P_{15}K_{20}$ kg ha^{-1} + 2.5 ton KWC ha^{-1}	3.84^{c}	2.59^{de}	14.54^{de}	20.97^{cd}	0.89^{bc}	0.89^{bcd}	7.37^{cd}	9.15^{cd}
T_{11}: $N_{60}P_{30}K_{40}$ kg ha^{-1} + 2,5 ton KWC ha^{-1}	3.02^{c}	1.25^{e}	6.89^{e}	11.16^{d}	0.95^{bc}	0.51^{bcd}	4.17^{d}	5.63^{d}
T_{12}: $N_{90}P_{45}K_{60}$ kg ha^{-1} + 2.5 ton KWC ha^{-1}	3.3^{c}	2.84^{cde}	16.31^{abcde}	22.45^{bcd}	0.69^{bc}	1.39^{cd}	10.01^{abcd}	12.09^{bcd}
T_{13}: $N_{120}P_{60}K_{80}$ kg ha^{-1} + 2.5 ton KWC ha^{-1}	5.54^{bc}	1.87^{bcde}	32.16^{a}	39.57^{abcd}	1.75^{bc}	0.22^{bcd}	11.68^{a}	13.65^{ab}
T_{14}: $N_{30}P_{15}K_{20}$ kg ha^{-1} + 5 ton KWC ha^{-1}	4.75^{c}	2.96^{abcde}	19.14^{abcde}	26.85^{abcd}	1.06^{bc}	3.24^{a}	10.25^{ab}	14.55^{ab}
T_{15}: $N_{60}P_{30}K_{40}$ kg ha^{-1} + 5 ton KWC ha^{-1}	11.18^{bc}	2.26^{abcd}	17.68^{abc}	31.12^{abc}	2.21^{bc}	1.14^{bcd}	9.96^{abc}	13.31^{ab}
T_{16}: $N_{90}P_{45}K_{60}$ kg ha^{-1} + 5 ton KWC ha^{-1}	2.79^{c}	5.21^{abc}	15.8^{bcde}	23.8^{bcd}	0.74^{bc}	1.68^{abcd}	9.79^{abcd}	12.21^{abcd}
T_{17}: $N_{120}P_{60}K_{80}$ kg $^{ha-1}$ + 5 ton KWC ha^{-1}	4.97^{c}	4.58^{a}	16.47^{abcde}	26.02^{abcd}	1.49^{bc}	1.62^{abcd}	3.32^{bcd}	6.43^{bcd}
T_{18}: $N_{30}P_{15}K_{20}$ kg ha^{-1} + 7.5 ton KWC ha^{-1}	6.73^{c}	3.84^{ab}	21.27^{abcde}	31.84^{abcd}	1.31^{bc}	1.28^{abc}	7.51^{abcd}	10.1^{abcd}
T_{19}: $N_{60}P_{30}K_{40}$ kg ha^{-1} + 7.5 ton KWC ha^{-1}	2.92^{c}	2.26^{abcde}	17.06^{abcde}	22.24^{abcd}	1.32^{bc}	1.13^{abcd}	7.35^{abcd}	9.8^{abcd}
T_{20}: $N_{90}P_{45}K_{60}$ kg ha^{-1} + 7.5 ton KWC ha^{-1}	4.37^{c}	1.45^{de}	22.31^{abcde}	28.13^{abcd}	3.04^{bc}	0.85^{abcd}	10.54^{abcd}	14.43^{abcd}
T_{21}: $N_{120}P_{60}K_{80}$ kg ha^{-1} + 7.5 ton KWC ha^{-1}	7.95^{bc}	3.55^{abcd}	21.74^{ab}	33.24^{ab}	2.15^{abc}	1.82^{bcd}	10.28^{abc}	14.25^{ab}
T_{22}: $N_{30}P_{15}K_{20}$ kg ha^{-1} + 10 ton KWC ha^{-1}	4.89^{c}	2.32^{cde}	25.07^{a}	32.28^{abcd}	1.65^{bc}	1.59^{bcd}	8.28^{abc}	11.52^{abc}
T_{23}: $N_{60}P_{30}K_{40}$ kg ha^{-1} + 10 ton KWC ha^{-1}	11.12^{bc}	3.17^{abcd}	20.78^{abcde}	35.07^{abcd}	3.87^{abc}	1.58^{abcd}	7.69^{abcd}	13.14^{abc}
T_{24}: $N_{90}P_{45}K_{60}$ kg ha^{-1} + 10 ton KWC ha^{-1}	40.65^{c}	3.22^{abcd}	16.43^{abcde}	60.3^{a}	9.8^{bc}	2.58^{ab}	9.53^{abcd}	21.91^{a}
T_{25}: $N_{120}P_{60}K_{80}$ kg ha^{-1} + 10 ton KWC ha^{-1}	0.7^{c}	2.55^{abcd}	16.57^{abcde}	19.82^{abcd}	0.4^{bc}	1.07^{abc}	10.24^{abc}	11.71^{abc}

^{abcdefghi} Data bearing different superscripts within the same column differ significantly at 5% level.

These findings of the study of fertilization treatment increase the available nutrients in the soil, for that particular reason, biomass production is increased (Han *et al.* 2016). The results showed that there were better performance with integrated organic source and chemical fertilizer in the biomass production of tomato. BARC (2018) also reported that the integration is essential to achieve sustainable yield.

Fruit

Significant ($p<0.05$) variations were observed in the number of fruit, longest length of fruit, fresh and dry weight of fruit (Table 4). Some fruits were red and some were green. The highest number of fruits were found in T_5: 10 ton KWC ha^{-1} (10 nos. $plant^{-1}$) and highest longest fruit (7.5 cm) was observed in T_5: 10 ton KWC ha^{-1}. The shortest fruit length (1.3 cm) was obtained in T_8: $N_{90}P_{45}K_{60}$kgha^{-1}. BARC (2018) reported that soil organic matter undergoes mineralization and releases substantial quantities of N, P, S and smaller amount of micronutrients which have a role in increasing the yield of crop. The present findings agreed with the report of BARC (2018).

Table 4. Effects of kitchen waste compost and chemical fertilizer on the number of fruits per plant, longest length of fruits, and fresh and dry weight of fruits.

Treatments	Fruit			
	Number per plant	Longest length(cm)	Fresh weight (g $plant^{-1}$)	Dry weight (g $plant^{-1}$)
T_1: Control (-KWC and -NPK)	3^{c}	5.8^{ab}	1.07^{e}	0.71^{d}
T_2: 2.5 ton KWC ha^{-1}	6^{bc}	6.3^{abc}	4.03^{cde}	2.44^{cd}
T_3: 5 ton KWC ha^{-1}	6^{ab}	5.3^{abc}	2.48^{cde}	1.77^{cd}
T_4: 7.5 ton KWC ha^{-1}	3^{abc}	6.1^{bcd}	3.43^{cde}	1.55^{bcd}
T_5: 10 ton KWC ha^{-1}	10^{a}	7.5^{a}	4.33^{bcde}	1.86^{bcd}
T_6: $N_{30}P_{15}K_{20}$kg ha^{-1}	3^{bc}	4.7^{bcd}	2.78^{cde}	1.44^{bcd}
T_7: $N_{60}P_{30}K_{40}$kg ha^{-1}	3^{c}	2.5^{efg}	4.20^{bcde}	3.19^{bcd}
T_8: $N_{90}P_{45}K_{60}$kg ha^{-1}	3^{c}	1.3^{fg}	1.87^{e}	1.60^{d}
T_9: $N_{120}P_{60}K_{80}$kg ha^{-1}	3^{c}	2.8^{efg}	2.92^{cde}	1.54^{bcd}
T_{10}: $N_{30}P_{15}K_{20}$ kg ha^{-1} + 2.5 ton KWC ha^{-1}	3^{c}	5.1^{def}	5.01^{bcde}	2.73^{bcd}
T_{11}: $N_{60}P_{30}K_{40}$ kg ha^{-1} + 2,5 ton KWC ha^{-1}	6^{abc}	3.6^{cde}	0.34^{de}	0.18^{d}
T_{12}: $N_{90}P_{45}K_{60}$ kg ha^{-1} + 2.5 ton KWC ha^{-1}	3^{bc}	2.4^{efg}	2.22^{de}	0.89^{d}
T_{13}: $N_{120}P_{60}K_{80}$ kg ha^{-1} + 2.5 ton KWC ha^{-1}	3^{bc}	2.3^{def}	3.40^{bcd}	2.80^{bcd}
T_{14}: $N_{30}P_{15}K_{20}$ kg ha^{-1} + 5 ton KWC ha^{-1}	5^{c}	3.4^{defg}	4.28^{bcde}	2.72^{bcd}
T_{15}: $N_{60}P_{30}K_{40}$ kg ha^{-1} + 5 ton KWC ha^{-1}	^{3bc}	4.2^{defg}	5.65^{bcde}	3.49^{bcd}
T_{16}: $N_{90}P_{45}K_{60}$ kg ha^{-1} + 5 ton KWC ha^{-1}	3^{c}	2.4^{efg}	2.83^{de}	0.79^{bcd}
T_{17}: $N_{120}P_{60}K_{80}$ kg $^{ha-1}$ + 5 ton KWC ha^{-1}	3^{bc}	2.8^{def}	4.14^{bc}	3.08^{abc}
T_{18}: $N_{30}P_{15}K_{20}$ kg ha^{-1} + 7.5 ton KWC ha^{-1}	6^{bc}	1.7^{g}	1.88^{de}	1.06^{d}
T_{19}: $N_{60}P_{30}K_{40}$ kg ha^{-1} + 7.5 ton KWC ha^{-1}	6^{abc}	4.5^{defg}	5.08^{bcd}	1.18^{bcd}
T_{20}: $N_{90}P_{45}K_{60}$ kg ha^{-1} + 7.5 ton KWC ha^{-1}	3^{c}	6.3^{bcd}	7.82^{bcd}	5.32^{ab}
T_{21}: $N_{120}P_{60}K_{80}$ kg ha^{-1} + 7.5 ton KWC ha^{-1}	6^{ab}	3.7^{def}	4.03^{bcde}	1.11^{d}
T_{22}: $N_{30}P_{15}K_{20}$ kg ha^{-1} + 10 ton KWC ha^{-1}	6^{abc}	2.5^{defg}	2.90^{bcd}	1.46^{bcd}
T_{23}: $N_{60}P_{30}K_{40}$ kg ha^{-1} + 10 ton KWC ha^{-1}	4^{abc}	1.3^{defg}	0.55^{cde}	0.32^{bcd}
T_{24}: $N_{90}P_{45}K_{60}$ kg ha^{-1} + 10 ton KWC ha^{-1}	3^{c}	5.6^{bcd}	13.48^{a}	5.29^{a}
T_{25}: $N_{120}P_{60}K_{80}$ kg ha^{-1} + 10 ton KWC ha^{-1}	3^{c}	3.7^{bcde}	6.22^{ab}	3.39^{bcd}

^{abcdefghi} Data bearing different superscripts within the same column differ significantly at 5% level.

The highest fresh weight (13.48 g $plant^{-1}$) and dry weight (5.32 g $plant^{-1}$) of fruits were recorded in T_{24}: $N_{90}P_{45}K_{60}$ kg ha^{-1} + 10 ton KWC $ha^{-1}$and T_{20}: $N_{90}P_{45}K_{60}$ kg ha^{-1} + 7.5 ton KWC ha^{-1} treatments, respectively and the lowest fresh weight (0.34 g $plant^{-1}$) and the lowest dry weight (0.18 g $plant^{-1}$) was recorded inT_{11}: $N_{60}P_{30}K_{40}$ kg ha^{-1} + 2.5 ton KWC ha^{-1} treatment. The study indicates that the combined application of kitchen waste compost (KWC) and NPK fertilizers (T_{24} treatment) can significantly accelerate better growth and yield of tomato than single application. Shweta and Sunita (2019) reported that the treatment comprising KWC and inorganic fertilizer showed significant effects on vegetative growth such as plant height, number of leaf, flowers and fruits of tomato. Results of the present study correlated well with the research findings of Rahman and Akter (2017).

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