# Effect of Household Solid Waste Compost on Growth and Yield of Tomato (*Lycopersicum esculentum* L.) in Agroforestry System


## ABSTRACT

Improvement of environment and soil fertility through utilization of compost produced from household organic solid waste is effective and agroforestry system is an effective technology to increase the production per unit of area. For this reason, a research was conducted to evaluate the performance of household solid waste compost on growth and yield performance of tomato in agroforestry system at the experimental field of Sher-e-Bangla Agricultural University, Dhaka during the period from November 2020 to June 2021. The experiment was conducted with five treatments viz. $T_1$, $T_2$, $T_3$, $T_4$ and $T_5$ as recommended dose of fertilizer, 10 ton/ha, 15 ton/ha, 20 ton/ha and 25 ton/ha household solid waste compost, respectively which were arranged by Randomized Completely Block Design (RCBD) with three replications. Moringa tree was used as tree species and BARI Tomato-2 was planted under moringa tree. The household solid waste compost showed effects on growth and yield performance of tomato compared to recommended dose. $T_3$, $T_4$ and $T_5$ showed significant effects on 80% flowering (DAT), fresh weight per plant, dry weight per plant, fruit number per plant, weight of individual fruit, fruit weight per plant, fruit yield per hectare compared $T_1$ (RDF) but $T_2$ (10 ton/ha) decreased significantly compared to RDF ($T_1$). Among those three treatments ($T_3$, $T_4$ and $T_5$), $T_5$ showed significant effects on fresh and dry weight of tomato plants, fruit number per plant, weight per fruit, total fruit weight per plant and fruit yield per hectare than $T_3$ and $T_4$. So, $T_5$ (25 ton/ha ) showed optimum yield of tomato in agroforestry system compared to recommended dose and other doses.



***Keywords:*** *Household; Solid waste compost; Tomato; Growth; Yield; Agroforestry*




## 1. INTRODUCTION

Bangladesh is a developing country. Its economic growth is rapid and also population growth is high. Due to economic growth and population growth, consumption of different product is increasing rapidly. As a result, a huge amount of solid waste produced in Bangladesh especially in the municipality. Bangladesh is generating about 8,000 tons of solid waste each day from the six major cities (Dhaka, Chittagong, Khulna, Rajshahi, Barisal and Sylhet), of which Dhaka city alone is contributing about 70% (Abedin and Jahiruddin, 2015) [1]. Approximately 25,000 tons of solid waste are generated daily in urban areas of Bangladesh, with 170 kilograms (kg) per capita per year (Ahmed, 2019) [2]. The volume of waste was 6,500 and 13,300 tons in 1991 and 2005 respectively (Dhaka Tribune, 2020) [3]. Due to fast urbanisation, changes in living standards of urban dwellers and the country's economic transitions toward a middle-income economy, the waste amount will continue to increase. As such, the per capita daily urban solid waste generation is projected to increase to 0.60 kg by 2025 from 0.49 kg in 1995 (Ahmed, 2019) [2]. Furthermore, a higher presence of organic items (70%) in waste composition provides the opportunity to transform waste into composting fertilizers. The use of organic fertilizers can improve food security by increasing crop production by 25–30% and reducing the necessity of chemical fertilizers by 35–40% along with job creation and reduction of emission of greenhouse gases (Dhaka Tribune, 2015) [4]. The average (HSW) generation rate was 0.26 kg/c/d and it was composed of organic waste (57.3%), plastics (14%), paper (10.9%), and glass and ceramic (1.3%) and other materials (16.5%) (Rawat and Daverey, 2018) [5]. Waste generation was 1.3 kg/household/day and 0.25 kg/person/day. Household solid waste (HSW) was comprised of nine categories of wastes with vegetable/food waste being the largest component (62%). Vegetable/food waste generation increased from the HSEG (47%) to the LSEG (88%). By weight, 66% of the waste was compostable in nature (Sujauddin et al., 2008) [6]. Among all solid waste most of them are decomposable that is produced mainly from household kitchen. But municipal authority cannot manage properly. As a result, this solid waste causes a dangerous hazard to environment. They pollute air, water, soil causes bad odor, different diseases etc. On the other hand, due to intensive and continuous cultivation of land the fertility especially organic matter of soil is rapidly decreasing in Bangladesh. In Bangladesh, most of the farmers use only chemical fertilizer without using organic fertilizer like compost, green manure etc. It is mainly due to scarcity of organic materials. As a result, soil quality is deteriorating gradually which is alarming for future agricultural production. So it is essential to apply organic fertilizer to soil. If household solid waste is used (organic part) to produce compost and use to the land then it will be beneficial for environment, health and also for soil fertility.

Vegetables are one of the essential food items of daily requirement which can contribute in overcoming such health hazard. So, improvement of daily dietary value depends largely on the vegetables consumption. The per capita consumption of vegetables in Bangladesh is only 53 g, which is far behind the daily requirement of 200 g/head (Rashid, 1999) [7]. This figure is lower than that of some other Asian countries like India (167 g), Pakistan (69 g), Sri Lanka (120 g), China (280 g) and Japan (248 g); the world average consumption being 250 g/head/day (Rampal and Gill, 1990) [8]. So, vegetable production and consumption need to be increased in Bangladesh. Vegetables are not produced evenly throughout the year in Bangladesh. About 35% of the vegetables are produced in summer season and the rest in the winter season (Rashid, 1999) [7].

The population is increasing and cultivable land is decreasing in Bangladesh. So it is very challenging to feed the people in future. In that case, agroforestry can play an important role to increase the production from limited land. In agroforestry system, vegetables are grown under the fruit and timber trees. There are about 20 million homesteads in Bangladesh which comprises about half million hectares of land (BBS, 2018) [9]. Most of the vegetables produced and consumed in this country are coming from homesteads agroforestry. These areas are also decreasing due to the construction of new houses for the ever increasing population. In this situation, vegetables cultivation needs to be increased in agroforestry system. Agroforestry, the integration of the tree, crop and vegetable on the same area of land is a promising production system for maximizing yield (Nair, 1990) and maintaining friendly environment [10].

Among the potential vegetables, Tomato is a very popular vegetable in Bangladesh. Unfortunately, using household solid waste compost (HSWC) in agroforestry system of this crop has not been studied in different agroforestry system. Considering the above mentioned facts a popular Tomato variety was selected in this study for evaluating the performance of HSWC under agroforestry system-

**i.** To evaluate the growth and yield contributing characters of tomato at different doses of HSWC in agroforestry system.

**ii.** To identify the most suitable dose of HSWC for agroforestry system.

## 2. MATERIALS AND METHODS

**i) Location:** Experimental field of Sher-e-Bangla Agricultural University. The experimental site was located between 23°74/N latitude and 90°35/E longitudes with an altitude of 8.2 m.

**ii) Plant materials:** Tomato variety (BARI Tomato -2)

**iii) Treatments:** The following household solid waste compost (HSWC) doses were maintained in this study to compare with recommended dose of fertilizer (RDF):

$T_1$-Recommended dose of fertilizer with basal dose (control)

$T_2$-10 ton/ha HSWC

$T_3$-15ton/ha HSWC

$T_{4-}$ 20ton/ha HSWC

$T_{5-}$ 25ton/ha HSWC

Basal dose of cowdung and fertilizer for recommended dose ($T_1$) were applied during final plough at 15th November, 2020 and then split fertilizer were used as recommended for tomato cultivation according to Bangladesh Agriculture Research Institute (BARI). Doses of household solid waste compost were applied at 15th November, 2020 during final land preparation.

**iv) Experimental design and layout**

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications under Moringa tree in the experiment field at Sher-e-Bangla Agricultural University. Each replication had five tomato plant.

**v) Uprooting and Transplanting of seedlings**

Seedlings of 30 days old on 22nd November 2020 were uprooted separately from the seedbed and transplanted properly.

**vi) Intercultural operations**

Intercultural operations were done whenever needed for better growth and development. Intercultural operations followed in the experiment were irrigation, weeding, staking, pesticide using etc.

**vii) Harvesting**

Harvesting was started during early ripe stage when the fruits attained slightly red color. Harvesting was done at 7 days' interval starting from 15th February and was continued up to 15th March, 2021.

**viii) Procedure of recording data**

Experimental data were recorded from 25 days after transplanting and continued until last harvest. The following data were recorded during the experimental period.

1. **Plant height**

Plant height was measured in centimeter from the ground level to the tip of the highest leaf and means value was calculated. To observe the growth rate plant height was recorded at 25, 45 and 60 days after transplanting (DAT).

2. **Plant stem diameter**

Plant stem diameter was measured in centimeter by using Vernier caliper. Stem diameter was recorded at 25, 45 and 60 days after transplanting.

3. **Number of leaves per plant**

Leaves number were counted from each plant at 25, 45 and 60 DAT.

4. **SPAD value of leaf**

SPAD value of the leaves of plant was measured by SPAD-meter.

5. **Number of branches per plant**

The total number of branches per plant were counted from each plant at 25 DAT, 45 DAT and 60 DAT.

6. **Date of 80% flowering**

Days of flowering at 4th plants among 5 plants were counted and recorded as date of 80% flowering.

7. **Fresh shoot weight**

All plants were selected from each replication and the sum of the fresh shoot of five plants were weighted and divided by 5, then it was recorded as fresh shoot weight per plant in 7gram.

8. **Dry shoot weight**

All plants were selected from each replication; then dry weight was recorded in gram in an oven at $70^0$ C until attained a constant weight was attained and then divided by 5.

9. **Number of fruits per plant**

The total number of fruits per plant was counted and recorded.

10. **Individual fruit weight**

Total weight of fruit was measured from each plant from 1st to last harvest and individual fruit weight was measured divided with the number of fruits per plant. Individual fruit weight was recorded in gram (g).

11. **Fruit weight per plant**

Fruit yield per plant was calculated by totaling fruit yield from first to final harvest and was recorded in gram (g).

12. **Fruit yield per ha**

Fruit yield per hectare was calculated by totaling fruit yield per square meter converted to hectare from first to final harvest and was recorded in ton (t).

**x) Statistical analysis**

All the obtained data were subjected to compiled and analyzed by microsoft Excel Worksheet and Statistix 10 software.

## 3. RESULT AND DISCUSSION

Results obtained from the study have been presented and discussed in this section with a view to evaluation of growth and yield performance of Tomato to compared the effect of household solid waste compost (HSWC) with recommended dose of fertilizer (RDF) in moringa *(Moringa oliefera)* tree as agroforestry system. The data are given in different tables and figures. The results have been discussed, and possible interpretations are given under the following headings.

### 3.1 Plant height

The following table (Table 1) presents the effect of HSWC on tomato plant height compared to RDF and showed that HSWC significantly affected on tomato plant height at different DAT. At 25 DAT, $T_4$ and $T_5$ showed higher plant height of tomato compared to $T_1$ but $T_2$ and $T_3$ showed statistically similar height with $T_1$. At 45 DAT, $T_4$ showed higher tomato plant height than $T_1$ but rest of treatments of HSWC performed statistically similar height of tomato plant with RDF ($T_{1)}$. In case of 60 DAT, Table1 showed that, $T_5$ produced significantly higher plants of tomato than $T_1$ and $T_3$ but except $T_5$, all the others HSWC doses showed statistically similar result of tomato plant height with RDF. The compost had effects on the average height of the plants of the tomato compared to the control (Larounga et al., 2022) [11].

**Table 1. Effect of household solid waste compost on plant height of Tomato at different DAT in Agroforestry system**

| Treatment | Plant height (cm) | | |
|---|---|---|---|
| | 25 DAT | 45 DAT | 60 DAT |
| $T_1$ | 12.297 B | 34.333 B | 48.083 B |
| $T_2$ | 13.503 AB | 35.210 AB | 52.333 AB |
| $T_3$ | 15.110 AB | 35.777 AB | 48.390 B |
| $T_4$ | 15.593 A | 39.000 A | 50.943 AB |
| $T_5$ | 15.720 A | 36.417 AB | 54.167 A |
| CV (%) | 7.36 | 4.25 | 3.91 |
| LSD (0.05) | | | |

DAT=Days After transplanting, T1=Recommended dose of fertilizer with basal dose (control), T2=10 ton/ha HSWC, T3=15ton/ha HSWC, T4=20ton/ha HSWC, T5=25ton/ha HSWC, LSD= least significant difference

### 3.2 Stem diameter

The following table (Table 2) presents the effect of HSWC on tomato plants stem diameter compared to RDF and showed that HSWC affected on tomato plants stem diameter at different DAT. At 25 DAT, $T_3$ and $T_5$ showed higher stem diameter of tomato compared than $T_1$ and $T_4$ but $T_2$ and $T_4$ showed statistically similar stem diameter with $T_1$. At 45 DAT, all the doses of HSWC ($T_2$, $T_3$, $T_4$ and $T_5$) showed significantly higher stem diameter of tomato plant stem than $T_1$ (RDF). In case of 60 DAT, table 2 showed that, $T_{3,}$ $T_4$, and $T_5$ produced significantly higher diameter of tomato plant stem than $T_1$ but $T_1$, and $T_2$ showed statistically similar result of tomato plant stem diameter.

**Table 2. Effect of household solid waste compost on stem diameter of Tomato at different DAT in Agroforestry system**

| Treatment | Stem diameter (cm) | | |
|---|---|---|---|
| | 25 DAT | 45 DAT | 60 DAT |

| | | | |
|---|---|---|---|
| $T_1$ | 0.64 B | 0.82 B | 0.90 B |
| $T_2$ | 0.71 AB | 0.88 A | 0.95 AB |
| $T_3$ | 0.79 A | 0.90 A | 0.98 A |
| $T_4$ | 0.64 B | 0.91 A | 0.99 A |
| $T_5$ | 0.79 A | 0.91 A | 1.00 A |
| CV (%) | 6.30 | 1.85 | 2.49 |
| LSD (0.05) | | | |

DAT=Days After transplanting, T1=Recommended dose of fertilizer with basal dose (control), T2=10 ton/ha HSWC, T3=15ton/ha HSWC, T4=20ton/ha HSWC, T5=25ton/ha HSWC, LSD= least significant difference

### 3.3 Leaf number per plant

Table 3 showed the effect of HSWC on tomato leaf number per plant compared to RDF at different DAT. At 25 DAT, all the doses of HSWC and RDF showed similar leaf number per plant but at 45 DAT, $T_5$ showed significantly higher leaf number per plant than RDF ($T_1$) and other doses of HSWC ($T_2$, $T_3$ and $T_4$). At 60 DAT, $T_5$ showed higher leaf number per plant compared to other treatments. $T_2$ showed lowest number of leaf per plant at 60 DAT compared to RDF and all the other doses of HSWC. Fertilization with organic compost from household food waste positively influenced the growth and nutrient assimilation in the leaf tissue of cherry tomato (Ferreira et al., 2018) [12].

**Table 3. Effect of household solid waste compost on leaf number per plant of Tomato at different DAT in Agroforestry system**

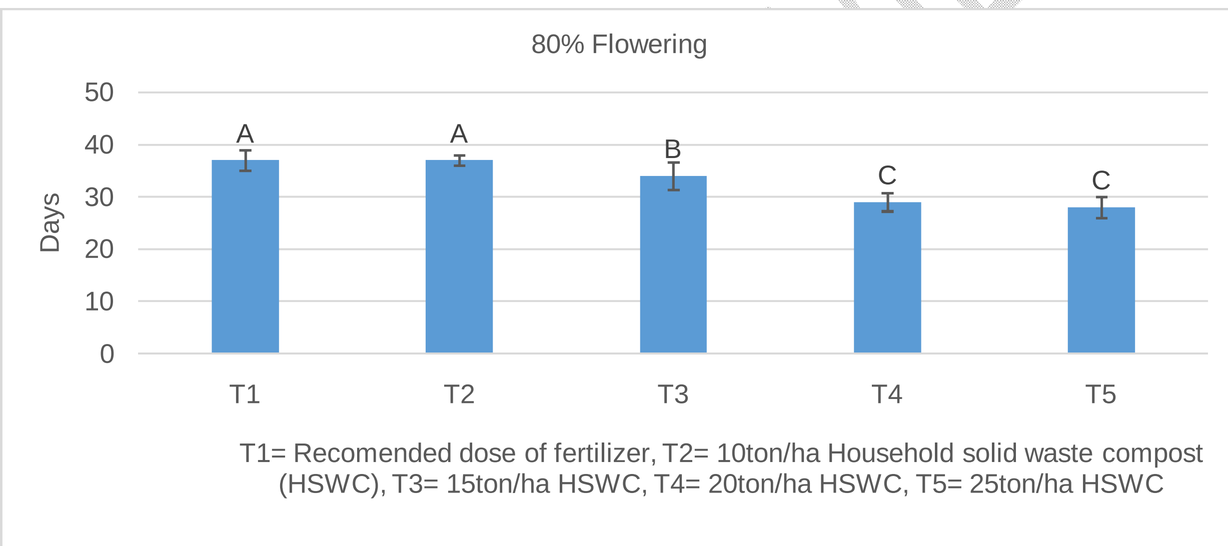
| Treatment | Leaf number per plant | | |
|---|---|---|---|
| | 25 DAT | 45 DAT | 60 DAT |
| $T_1$ | 6.92 A | 20.61 B | 33.58 B |
| $T_2$ | 7.25 A | 19.17 B | 28.64 C |
| $T_3$ | 7.42 A | 20.67 B | 34.25 B |
| $T_4$ | 6.75 A | 21.08 B | 35.17 AB |
| $T_5$ | 7.50 A | 23.50 A | 36.83 A |

| | | | |
|---|---|---|---|
| CV (%) | 5.17 | 3.84 | 2.73 |
| LSD (0.05) | | | |

DAT=Days After transplanting, T1=Recommended dose of fertilizer with basal dose (control), T2=10 ton/ha HSWC, T3=15ton/ha HSWC, T4=20ton/ha HSWC, T5=25ton/ha HSWC, LSD= least significant difference

**3.4 80% flowering (DAT)**

HSWC had positive effect on flowering. HSWC reduced the 80% flowering DAT compared to RDF. Figure 1 showed that, $T_5$ and $T_4$ took least time for 80% flowering and $T_1$ and $T_2$ took highest time. $T_3$ and $T_4$ also needed less time than $T_1$ for 80% flowering.




DAT=Days After transplanting, T1=Recommended dose of fertilizer with basal dose (control), T2=10 ton/ha HSWC, T3=15ton/ha HSWC, T4=20ton/ha HSWC, T5=25ton/ha HSWC, LSD= least significant difference

**Figure 1. Effect of household solid waste compost on flowering (80%) DAT of Tomato in Agroforestry system**

**3.5 SPAD value of leaf**

HSWC had no significant effect on SPAD value of leaf compared to RDF (Figure 2).

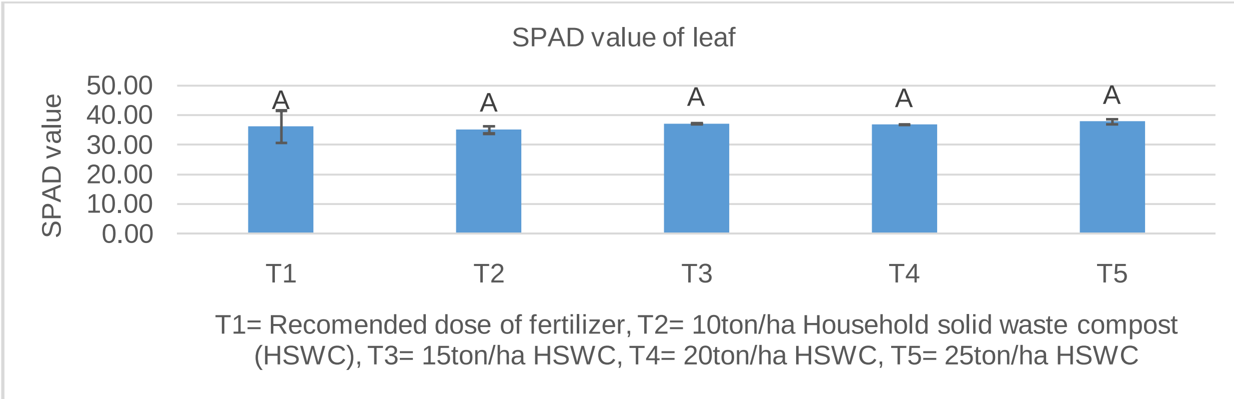



**Figure 2. Effect of household solid waste compost on Chlorophyll content of Tomato in Agroforestry system**

### 3.6 Branch number per plant

HSWC had no significant effect on number of branch per plant compared to RDF (Figure 3).

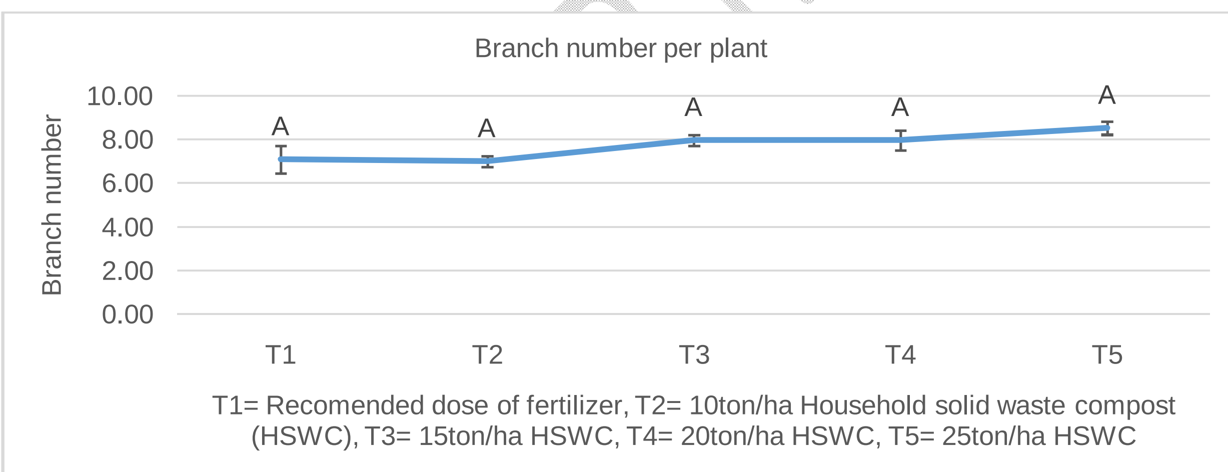



**Figure 3. Effect of household solid waste compost on number of branch per plant of Tomato in Agroforestry system**

### 3.7 Fresh shoot weight

All the HSWC doses ($T_3$, $T_4$ and $T_5$) except $T_2$ showed significant effect on fresh shoot weight per plant of tomato compared to RDF (Figure 4). Fresh shoot weight per plant of tomato in $T_5$, $T_4$ and $T_3$ were higher than $T_1$ but $T_2$ showed lowest fresh shoot weight per plant. $T_5$ showed highest fresh shoot weight per plant.

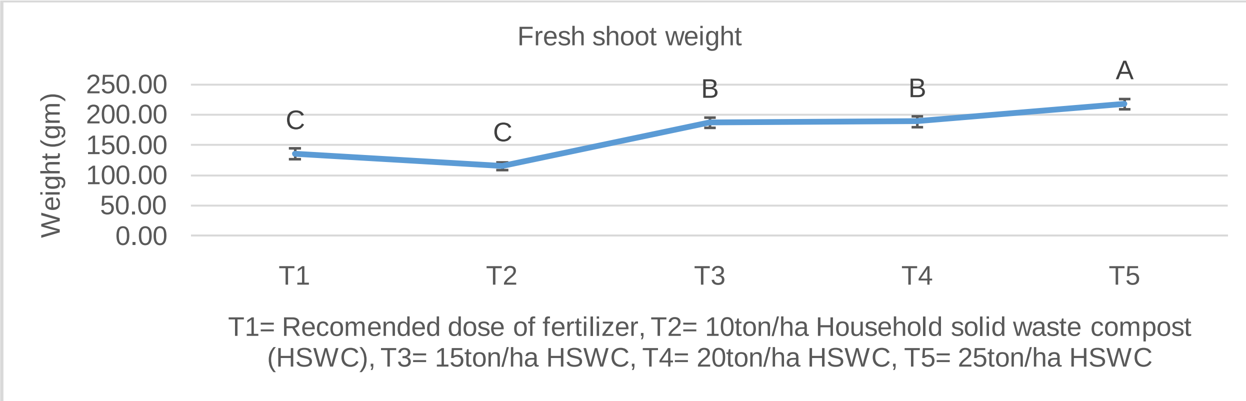



**Figure 4. Effect of household solid waste compost on fresh shoot weight of per plant of Tomato in Agroforestry system**

### 3.8 Dry shoot weight

All the HSWC doses ($T_3$, $T_4$ and $T_5$) except $T_2$ showed positive effect on dry shoot weight per plant of tomato (Figure 5). Dry shoot weight per plant of tomato in $T_5$, $T_4$ and $T_3$ were higher than $T_1$ but $T_2$ showed lowest dry shoot weight per plant. $T_5$ showed highest dry shoot weight per plant.

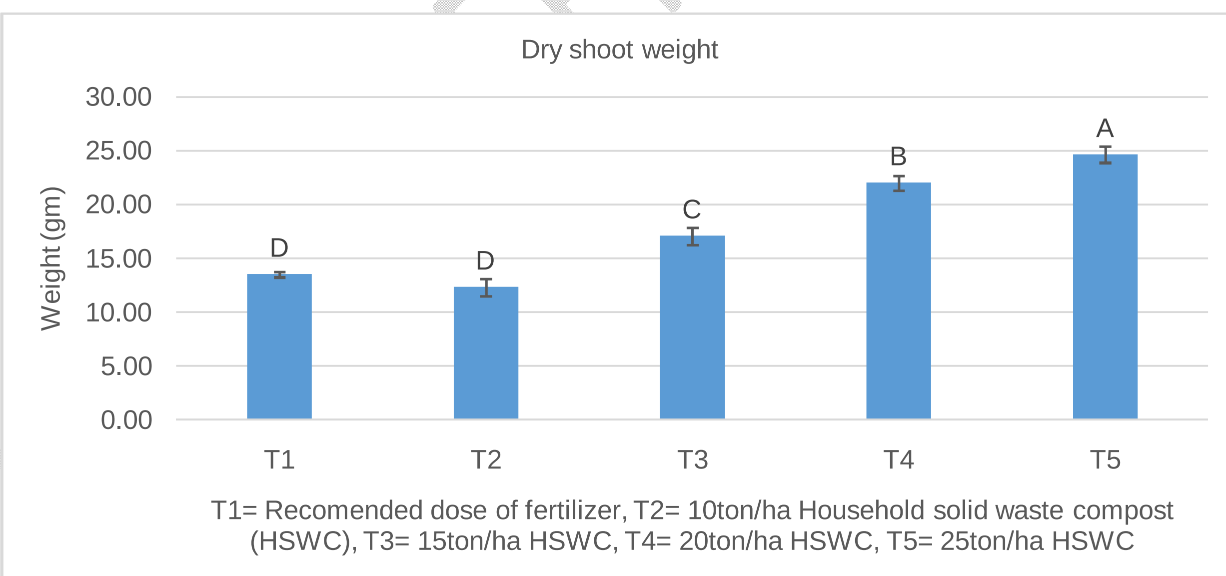



**Figure 5. Effect of household solid waste compost on dry shoot weight per plant of Tomato in Agroforestry system**

### 3.9 Fruit number per plant

Fruit number per plant was significantly affected due to use of HSWC except one dose ($T_2$) compared to RDF. $T_5$ showed highest fruit per plant than all others treatment ($T_1$, $T_2$, $T_3$ and $T_4$). $T_3$, $T_4$ and $T_5$ were produced significantly higher number of fruit per plant than $T_1$ but $T_2$ produced significantly lowest fruit per plant (Figure 6). Larounga et al., (2022) found similar result that the compost had effects on the average number of fruits per plant of the tomato compared to the control [11].

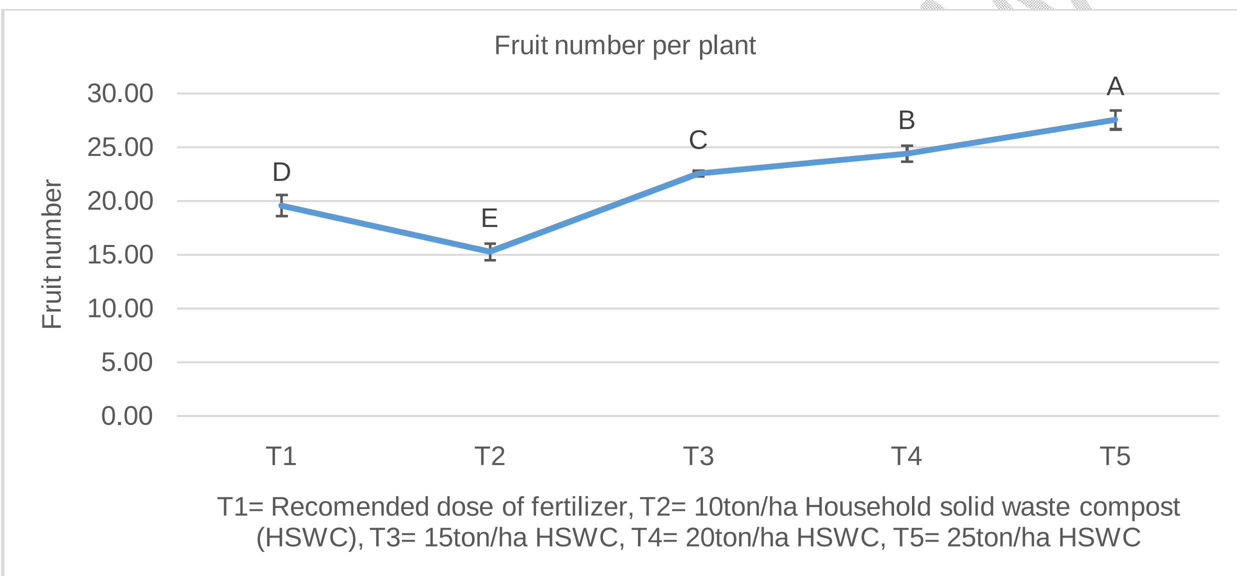



**Figure 6. Effect of household solid waste compost on fruit number per plant of Tomato in Agroforestry system**

### 3.10 Individual fruit weight

Figure 7 showed individual fruit weight was significantly affected due to the use of HSWC except one dose ($T_2$) compared to RDF. $T_5$ and $T_4$ showed highest individual fruit weight than all others treatments ($T_1$, $T_2$ and $T_3$). $T_3$, $T_4$ and $T_5$ were produced significantly higher individual fruit weight than $T_1$ but $T_2$ produced significantly lowest individual fruit weight. Salam et al., (2021) revealed that the fresh weight of tomato was significantly increased ($P < .001$) with higher rate of sole MSWC application and significantly higher at 15 ton/ha [13].

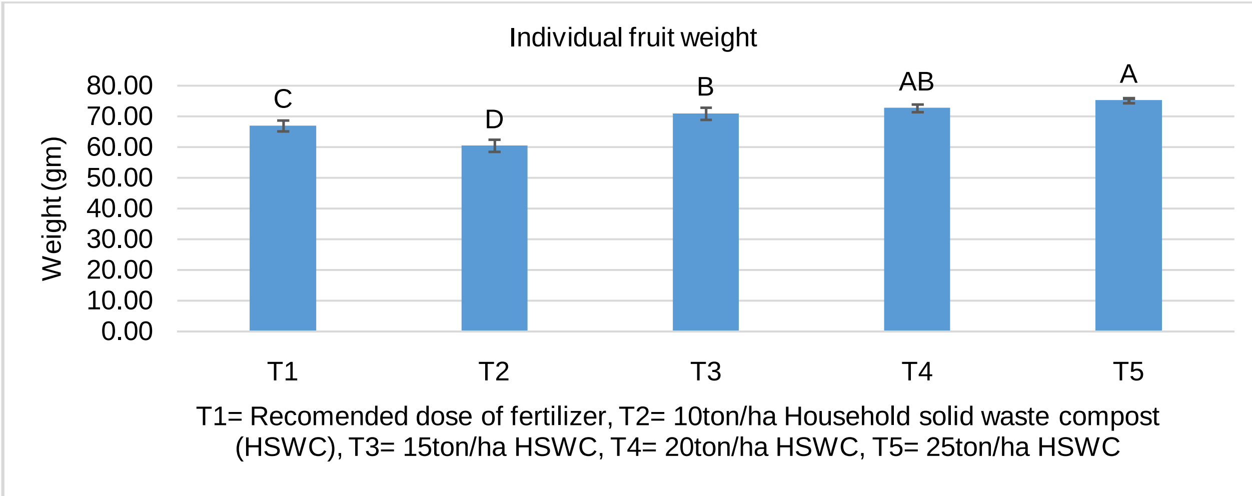



**Figure 7. Effect of household solid waste compost on weight per fruit of Tomato under Agroforestry system**

### 3.11 Fruit yield per plant

Table 4 showed that, fruit yield per plant was significantly affected due to use of HSWC except one dose ($T_2$) compared to RDF. $T_5$ showed significantly higher fruit yield per plant than all others treatment ($T_1$, $T_2$, $T_3$ and $T_4$). $T_3$, $T_4$ and $T_5$ were produced significantly higher fruit yield per plant than $T_1$ but $T_2$ produced significantly lower fruit yield per plant. The urban organic wastes showed significant effects on the growth of different traits of tomato (Pattnaik and Reddy, 2010) [14]. MSWC has been shown to benefit the growth and yield of several crops, including some horticultural plants, in most cases, but this depends on several factors such as application load (Hargreaves et al. 2008) [15].

### 3.12 Fruit yield per hectare

Fruit yield per hectare was significantly affected due to use of HSWC except one dose ($T_2$) compared to RDF. $T_5$ showed significant higher fruit yield per hectare than all other treatments ($T_1$, $T_2$, $T_3$ and $T_4$). $T_3$, $T_4$ and $T_5$ were produced significantly higher fruit yield per hectare than $T_1$ but $T_2$ produced significantly lowest fruit yield per hectare (Table 4). The application of compost from household waste (10 t.ha-1, 20 t.ha-1, 30 t.ha-1 and 40 t.ha-1) induced an increased fruit yield (8.61ton/ha to 36.43 ton/ha) of tomato (Larounga et al., 2022) [11]. Demirtaş et al. (2016) revealed that, urban solid waste compost increased the yield of tomato [16].

**Table 4. Effect of household solid waste compost on yield of Tomato in Agroforestry system**

| Treatment | Fruit yield per plant (g) | Total fruit yield per hectare (ton) |
|---|---|---|
| $T_1$ | 1310.4 D | 55.08 D |
| $T_2$ | 921.9 E | 38.72 E |
| $T_3$ | 1597.5 C | 67.1 C |
| $T_4$ | 1771.6 B | 74.40 B |
| $T_5$ | 2068.3 A | 86.87 A |
| CV% | 2.89 | 2.89 |
| LSD (0.05) | | |

T1=Recommended dose of fertilizer with basal dose (control), T2=10 ton/ha HSWC, T3=15ton/ha HSWC, T4=20ton/ha HSWC, T5=25ton/ha HSWC,

LSD= least significant difference



## 4. CONCLUSION

Both growth and yield performance of tomato were affected due to the application of household solid waste compost compared to recommended dose of fertilizer. It was found that all the doses (10 tons/ha, 15 tons/ha, 20 tons/ha, and 25 tons/ha respectively) had significant effects on growth and yield contributing characters of tomato. $T_3$, $T_4$ and $T_5$ produced significantly higher yield than $T_1$ and $T_2$ produced lower yield than $T_1$. Among those HSWC treatments ($T_2$, $T_3$, $T_4$ and $T_5$) $T_5$ showed significant higher fresh and dry shoot weight of tomato plants, fruit number per plant, individual fruit weight. total fruit weight per plant and fruit yield per hectare than $T_2$, $T_3$ and $T_4$. The sequence of tomato yield was $T_5$>$T_4$>$T_3$>$T_1$>$T_2$. 10 ton HSWC compost/ha produced lower yield of tomato than RDF and 25 ton HSWC compost/ha produced optimum yield which was higher than RDF.

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**Authors' contributions:** This work was carried out in collaboration among all authors. Authors AH, AKB and MKH designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author ZFBH managed the analyses of the study. Author MDM and FA managed the literature searches. All authors read and approved the final manuscript.

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