Effect of solid wastes amendment on growth and yield of *Solanum melongena*

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**ABSTRACT**

In the present study four different types of organic solid wastes namely: sugarcane waste, fish waste, flower waste and pineapple waste were selected and amended in soil. Plantation of saplings of *Solanum melongena* were done in the amended soil and changes in the growth pattern, biomass and soil characteristics were observed by comparing with unamended pots. It was observed that amendment of flower waste leads to an overall increase in the productivity of crop. On an average there was an increase of 11.7 cm in height, 13 number of leaves, 5 cm in root length and 3.4 g of biomass in the flower waste amended pots. Sugarcane and fish wastes amendment did not show positive impact on the crop. Pineapple wastes showed positive change. Soil moisture, organic C and N increased in all types of amendments. Available K increased only in flower and pineapple wastes amendment. There was significant correlation between crop and soil characteristics showing faster release of K in flower waste led to an increase in production of the crop.

**Key words**: Available K, Bulk density, Flower waste, Pineapple waste, Sugarcane waste.

**INTRODUCTION**

Generation of solid wastes in urban as well as rural areas of the Indian sub-continent has increased manifold due to increase in population and economic growth. Segregation of solid wastes at source level and proper management is not systematically carried out in India. Open dumping and landfills are the main options for managing solid wastes. However, under *Swachh Bharat* Mission initiatives on conversion of organic wastes into compost have recently started, which is a new starting point for proper management of solid wastes. Utilization of organic wastes in the form of compost or direct application in crop fields in soil reduces the burden of discarding the wastes in fields. Compost production involved technical knowledge and labor which is a difficult task for the farmers (Adediran et. al., 2008). Demand for organically grown vegetables that are free from residual contaminants causing health hazards have increased (Willer and Wilcher, 2011). Complete organic production warrants the use of organic sources and botanicals in plant nutrition, plant protection and all other related crop production practices (Pradeepkumar et. al., 2017). Anbukkarasi and Sagasakthi (2017) and Koshov and Icnnicov (2017) have shown treatment of organic materials on crop fields have positive impact on crop yield.

The present study emphasizes changes on growth pattern and production of the crop *Solanum melongena* due to amendment of four different types of organic solid wastes in soil.

**MATERIALS AND METHODS**

**Experimental design:** The study was carried out in Dhanamanjuri College of Science, Imphal West which lies between 24°30’N to 25°00’N latitudes and 93°45’ E to 94°15’E longitudes. Annual rainfall ranges from 108.5 cm to 143.4 cm. The average temperature is 20.4°C. Four different types of solid wastes were selected for the present study. They were: Sugarcane waste, fish waste, flower waste comprising of marigold and pineapple waste. These types of wastes were collected and air dried till constant weight and shredded into small pieces. Sixteen earthen pots were filled up with the dried wastes at a ratio of 50g of each type of wastes with one kg of dried soil making three pots for each types of wastes amendment. Another three pots were filled up with soil without any wastes in order to make control pots. Completely randomized design was maintained for the study. All the fifteen pots were kept for one month during February, 2016 in order to let the wastes amended soil to stabilise.

**Crop plantation:** Saplings of *Solanum melongena* having same growth stage were collected and planted in the pots in the month of March, 2016. They were watered regularly. The growth pattern was recorded based upon the increase in height, number of leaves and fruit. Recordings were done twice every month for four months. The fallen leaves and flower were collected separately for each pot for inclusion in biomass. Productivity of the crop was determined by taking dry biomass after harvesting the crops. The root lengths were also recorded. Analysis of soil was done once for three replicates for each pot after taking the soil samples.
just after harvesting the crop. Soil pH was determined by using pH meter, moisture content by oven dry method, organic carbon by Walkley and Black’s method outlined in Anderson and Ingram (1993), available N by Subbaiah and Asiga method (1956), available P by using Bray and Kurtz method and available K by Flame Photometer outlined in Basak (2006).

RESULTS AND DISCUSSION

The change in crop and soil characteristics were recorded by finding out the difference between amended and control pots taking average readings. Statistically significant amendment effects was observed on the height of crop ($F_{4,10}=17.76; P<0.05$) and number of leaves ($F_{4,10}=9.74; P<0.05$). No significant effect of amendment on root length and biomass were observed. Least significant differences for the analysis of variance are given in Table 1 and 2.

By comparing between the wastes amended and control pots positive change in height of the crop was observed in the pots amended with flower and pineapple wastes (Table 3). There was a maximum average increase of 11.7 cm in height of the crop in the flower wastes amended pots. In the fish and sugarcane wastes amended pots there was no positive change in the height from the control pots. Maximum increase of 13 leaves in flower waste and a minimum of 1 in sugarcane waste amended pots, and no increase in number of leaves was observed in fish waste amended pots over control. The length of root changed positively only in flower wastes amended pots with an average of 5 cm. The biomass of crop in the fish wastes amended pots declined from control pots. There was positive change in sugarcane, flower and pineapple wastes amended pots. Maximum increase of an average of 3.4g was observed in the pots amended with flower wastes. Overall the amendment of fish and sugarcane wastes does not have any positive impact on the growth pattern of the crop although there was a slight increase in biomass in sugarcane amendment pots. Whereas, the amendment of flower and pineapple

### Table 1: LSD between means of height of crop (cm) under different treatments. Differences larger than 4.99 are significant at $\alpha=0.05$ level and are indicated with *, differences larger than 7.07 are significant at $\alpha=0.01$ level and are indicated with **.

| Types of wastes | Control | sugarcane | fish | flower | pineapple |
|-----------------|---------|-----------|------|--------|-----------|
| Control         | 15.6±0.47 | 6±0.94 | 7.0±0.81 | 7.6±0.12 |
| Sugarcane       | 12.0±1.41(-3.6) | 7±0.81(1) | 6.6±1.20(-0.4) | 8.1±0.16(0.5) |
| Fish            | 11.6±1.70(-4.0) | 5±0.81(-1) | 7.0±1.63(0) | 6.1±0.26(-1.5) |
| Flower          | 27.3±3.70(11.7) | 19±4.50(13) | 12.0±3.55(5) | 11.0±0.12(3.4) |
| Pineapple       | 21.6±2.62(6.0) | 13±3.55(7) | 7.0±2.16(0) | 9.1±0.20(1.5) |

### Table 2: LSD between means of number of leaves under different treatments. Differences larger than 5.85 are significant at $\alpha=0.05$ level and are indicated with *, differences larger than 8.31 are significant at $\alpha=0.01$ level and are indicated with **.

| Types of wastes | Control | sugarcane | fish | flower | pineapple |
|-----------------|---------|-----------|------|--------|-----------|
| Control         | 0.00 | 3.6* | 4.0** | 11.7** | 6.0* |
| Sugarcane       | - | 0.0 | 0.4** | 15.3** | 9.6** |
| Fish            | - | - | 0.0 | 17.7** | 10.0** |
| Flower          | - | - | - | 0.0 | 5.7* |
| Pineapple       | - | - | - | - | 0.0 |

### Table 3: Growth pattern of crop (Solanum melongena) under control and amended pots. The figures within bracket indicate the change due to amendment of wastes.

| Types of wastes | Height(cm) | No of leaves | Root length(cm) | Biomass(g) |
|-----------------|------------|--------------|-----------------|------------|
| Control         | 15.6±0.47 | 6±0.94       | 7.0±0.81        | 7.6±0.12   |
| Sugarcane       | 12.0±1.41(-3.6) | 7±0.81(1) | 6.6±1.20(-0.4) | 8.1±0.16(0.5) |
| Fish            | 11.6±1.70(-4.0) | 5±0.81(-1) | 7.0±1.63(0) | 6.1±0.26(-1.5) |
| Flower          | 27.3±3.70(11.7) | 19±4.50(13) | 12.0±3.55(5) | 11.0±0.12(3.4) |
| Pineapple       | 21.6±2.62(6.0) | 13±3.55(7) | 7.0±2.16(0) | 9.1±0.20(1.5) |

### Table 4: LSD between means of soil moisture content (%) under different treatments. Differences larger than 7.15 are significant at $\alpha=0.05$ level and are indicated with *, differences larger than 10.14 are significant at $\alpha=0.01$ level and are indicated with **.

| Types of wastes | Control | sugarcane | fish | flower | pineapple |
|-----------------|---------|-----------|------|--------|-----------|
| Control         | 0.00 | 14.9** | 3.7** | 16.6** | 10.6* |
| Sugarcane       | - | 0.0 | 11.2** | - | 1.7* |
| Fish            | - | - | 0.0 | 12.9** | 6.9* |
| Flower          | - | - | - | 0.0 | 6.0* |
| Pineapple       | - | - | - | - | 0.0 |
wastes have positive impact on the growth and production of the crop. Statistical significant amendment effects were observed on soil moisture \((F_{4,10}=9.74; P<0.05)\); available P \((F_{4,10}=19.18; P<0.05)\) and available K \((F_{4,10}=4.44; P<0.05)\). LSD for the significant amendment effects are shown in Tables 4, 5 and 6. No statistically significant effect of amendment on bulk density, organic C and N was observed. Soil moisture showed positive change (Table 7) in all the amendments with a maximum of 16.60% on an average in flower wastes amended pots and a minimum of 3.70% on an average in fish wastes amended pots. The soil was overall acidic having a range of 6.6 to 7.2. The change in pH does not follow a definite pattern, however, in all amendments there was a slight increase in pH level except in fish waste amended pots. The increase in pH level was also observed in municipal solid waste compost application by Warman et al., (2009) which does not have negative impact on fruit yield.

Organic C and available N showed overall positive change on an average in all amendments although no statistical significance was observed. This can have impact on soil moisture and bulk density. Available P changed positively only in fish (29.70 kg/ha) and flower wastes (5.70

### Table 5: LSD between means of soil available P (kg/ha) under different treatments. Differences larger than 7.93 are significant at \(\alpha=0.05\) level and are indicated with *, differences larger than 11.24 are significant at \(\alpha=0.01\) level and are indicated with **.

| Type of waste | Control | Sugarcane | Fish | Flower | Pineapple |
|---------------|---------|-----------|------|--------|-----------|
|                | 0.00    | 2.7**     |       | 5.7*   | 3.0*      |
|                | 2.7**   |           | 32.4* | 8.4*   | 0.3*      |
|                | 0.0     |           | 0.0   | 24.0** | 32.7**    |
|                | -       |           | -     | 0.0    | 8.7*      |

### Table 6: LSD between means of soil available K (kg/ha) under different treatments. Differences larger than 70.33 are significant at \(\alpha=0.05\) level and are indicated with *, differences larger than 99.76 are significant at \(\alpha=0.01\) level and are indicated with **.

| Type of waste | Control | Sugarcane | Fish | Flower | Pineapple |
|---------------|---------|-----------|------|--------|-----------|
|                | 0.00    | 2.4**     | 7.6**| 104.3**| 13.6**    |
|                | 2.4**   |           | 7.6**| 104.3**| 13.6**    |
|                | 10.0**  |           |      |        |           |
|                | 3.0**   |           |      |        |           |
|                | 106.7** |           |      |        |           |
|                | 16.0**  |           |      |        |           |
|                | 114.3** |           |      |        |           |
|                |         |           |      |        |           |
|                | 90.7**  |           |      |        |           |

### Table 7: Physico-chemical characteristics of soil under control and amended pots. The figures within bracket indicates change due to amendment of wastes.

| Type of waste | Soil moisture (%) | Bulk density (g/cm³) | pH | C (%) | N(kg/ha) | P(kg/ha) | K(kg/ha) |
|---------------|-------------------|----------------------|----|-------|----------|----------|----------|
| Control       | 12.6±1.53         | 1.6±0.03             | 6.7±0.01 | 0.40±0.08 | 167.3±14.61 | 6.3±4.02 | 101.0±30.40 |
| Sugarcane     | 27.5±2.01         | 1.5±0.08             | 7.2±0.02 | 0.43±0.05 | 240.6±14.61 | 3.6±0.94 | 98.6±10.53 |
| Fish          | 16.3±2.31         | 1.4±0.08             | 6.6±0.01 | 0.43±0.12 | 250.6±44.31 | 36.0±6.5 | 91.0±17.20 |
| Flower        | 29.2±6.00         | 1.3±0.12             | 6.7±0.03 | 0.44±0.12 | 188.0±51.43 | 12.0±2.16 | 205.3±60.01 |
| Pineapple     | 23.2±2.20         | 1.3±0.20             | 6.9±0.01 | 0.46±0.18 | 199.0±29.70 | 3.3±0.47 | 114.6±10.07 |
|               | (14.90)           | (-0.10)              | (0.50)   | (0.03)  | (73.30)  | (-2.70)  | (-2.40)   |
|               | (3.70)            | (-0.20)              | (-0.1)   | (0.03)  | (83.30)  | (29.70)  | (-10.00)  |
|               | (16.60)           | (-0.20)              | (0)      | (0.04)  | (20.70)  | (5.70)   | (104.30)  |
|               | (10.60)           | (-0.30)              | (0.20)   | (0.06)  | (31.70)  | (-3.00)  | (13.60)   |

organic C and N was observed. Soil moisture showed positive change (Table 7) in all the amendments with a maximum of 16.60% on an average in flower wastes amended pots and a minimum of 3.70% on an average in fish wastes amended pots. The soil was overall acidic having a range of 6.6 to 7.2. The change in pH does not follow a definite pattern, however, in all amendments there was a slight increase in pH level except in fish waste amended pots. The increase in pH level was also observed in municipal solid waste compost application by Warman et al., (2009) which does not have negative impact on fruit yield.

Organic C and available N showed overall positive change on an average in all amendments although no statistical significance was observed. This can have impact on soil moisture and bulk density. Available P changed positively only in fish (29.70 kg/ha) and flower wastes (5.70 kg/ha) and flower wastes (5.70 kg/ha).
kg/ha) amendments, whereas in pineapple waste amended pots no change was observed. Available K showed massive positive change in flower waste amendment (104.30kg/ha) followed by pineapple waste amendment (13.60kg/ha).

The results of regression analysis are shown in Figs.1-8. The Pearson’s coefficient of correlation was calculated for the crop characteristics and soil properties. It was observed that height of crop was significantly and negatively correlated with bulk density ($r = -0.72$, $P<0.05$) and positively correlated with available K ($r = 0.89$, $P<0.05$); number of leaves positively correlated with soil moisture ($r = 0.71$, $P<0.05$), negatively correlated with bulk density ($r = -0.84$, $P<0.05$) and positively correlated with available K ($r = 0.92$, $P<0.01$); root length with available K ($r = 0.98$, $P<0.01$); biomass with soil moisture ($r = 0.73$, $P<0.05$) and available K ($r = 0.89$, $P<0.01$). No significant correlation was observed between crop characteristics with soil organic C, N and P. However, all the crop characteristics showed positive and significant correlation with available K. In our earlier study similar response to flower and pineapple wastes due to availability of K on Capsicum annum was observed (Yaiphabi et al., 2017). A study conducted by Dhar et al., (2014) showed that the yield of wheat and availability of organic carbon, N, P and K in soil increased due to incorporation of straw.
The results indicated that release of available K to the roots of *Solanum melongena* was more than C, N and P from the different types of wastes amendment in soil. Since the amendment of flower leads to a massive increase in the level of available K, the productivity of the crop was maximum. As the study was carried out for a short period of time, the availability of C, N and P to the crop may not be complete. Studies of Ryals and Silver (2013) in a grassland in California showed that a single application of composted organic matter led to sustained increase in net primary productivity for at least three years. Therefore, a long term study in agricultural fields will suffice the outcome of the present work.

**CONCLUSION**

From all the observations made it can be concluded that a rapid supply of available K to *Solanum melongena* was made by amendment of flower waste leading to massive increase in crop production.

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