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Title: Effect of Decomposed Fruit Waste on the Growth and Biomass Production of Red Amaranth (*Amaranthus cruentus*)

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ABSTRACT

This study attempts to observe the effect of decomposed fruit waste on the growth and biomass production of red amaranth *(Amaranthus cruentus).* Decomposed fruit waste used as organic fertilizer to ensure soil health. Besides, the use of organic fertilizer instead of using toxic chemical fertilizer is an alternative eco-friendly approach. In this experiment, compost was prepared by using banana and orange peel wrapped in two different poly bags and kept them for 6 months under the soil. Here five treatments and three replications were used in which 1000 kg ha^{1} and 2000 kg ha^{-1} orange peel and banana peel composts were used as treatments. Red amaranth was grown as a test crop. After harvesting plants, different growth parameters such as shoot length, root length, leaf number, fresh weight, oven-dry weight and percent of moisture content were measured. The results exhibited that all growth parameters increased significantly by the application of decomposed fruit wastes. However, the application of 2000 kg ha^{-1} decomposed orange peel performed better in all respects.
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INTRODUCTION

Banana and orange are the common fruits in Bangladesh. These are also grown widely in different countries of the world. Orange is one of the most important and widely grown fruit crops with total global production reported to be around 120 million tons. Orange fruit is cultivated in more than 130 countries including India, UK, France, Germany, Holland, China and Spain (Parle and Chaturvedi, 2012). Banana is the most widely cultivated fruit in tropical and subtropical countries (Sarker et al., 2020). In Bangladesh, nearly one million ton of bananas are produced annually (Hossain, 2014). Banana and orange peels are rich in fiber, polyphenols and low in protein but their composition varies according to the species and the variety as well as the stage of maturation (Emaga et al., 2007).

A large number of bananas and oranges are produced annually and their peel adds extra waste load. This waste is dumped on the adjacent rivers or thrown here and there on soil causes environmental pollution (Wadhwa and Bakshi, 2013). Fertilizers are any organic or inorganic material of natural or synthetic origin which is added to soil to supply one or more plant nutrients essential for the growth of the plants (Mercy and Jenifer, 2014). The soil fertility is maintained by the presence of organic matter in the soil (Billah et al., 2011). Thus, compost is a good organic fertilizer because it contains nutrients as well as organic matter.

Organic matter has some important roles to play in soils both in their physical structure and as a medium for biological activity (Edwards and Araya, 2011). Banana and orange peels could be used to prepare compost for using as an organic fertilizer for crop cultivation. Their use would also enhance soil health through supplying necessary plant nutrients. Such utilization of the peels would reduce the waste load and limit the use of costly and harmful chemical fertilizers (Nevens and Reheul, 2003). In respect of these considerations, the current experiment was conducted to evaluate the effect of decomposed banana and orange peels on the growth and biomass production of Red amaranth (*Amaranthus cruentus*) as test crop.

MATERIAL AND METHODS

Banana and orange peels were wrapped in two different poly bags and kept them for 6 months under the soil and applied on a test crop Red amaranth (*Amaranthus cruentus*) to investigate the impact on the growth and biomass production through pot experiment. This particular crop has gained popularity among the farmers as it can be grown round the year with high yield and can be harvested in a short period of time (one month).

Treatments of the experiment

Five treatments with three replications were used in the experiment for the test crop. The treatments are as follows:

T0= Control (No compost)
T1= Banana peel compost (1000 kg ha^{-1})
T2= Orange peel compost (1000 kg ha^{-1})
T3= Banana peel compost (2000 kg ha^{-1})
T4= Orange peel compost (2000 kg ha^{-1})

The nutrient value of composted banana and orange peel (Condé Nast, 2018):

	N (%)	Ca (ppm)	P (ppm)	K ppm)
Banana peel	0.124	19.20	211.30	78.10
Orange peel	0.117	9.7	1.3	12.7

Sowing of seeds

Only 15 seeds of Red amaranth were sown on 24 March 2019 in each pot. The seeds were sown thoroughly and covered by soil. After germination on the sixth day, five plants per pot were maintained for observations until harvest. Germination test was conducted before sowing the seeds and 85% of germination rate was found from the sample. About 3 kg of soil was used in each pot.

Harvesting

The experimental crop was harvested after 30 days of sowing on 24th April 2019. The harvested plants were tagged separately, weighed, oven-dried at 65^0C temperature for 72 hours until moisture content reached at a constant minimum level. The dried material of samples from each treatment was weighted.

Plant growth factors

Number of leaves per plant (Nos.): The number of leaves of five plants from each pot was counted and an average value was recorded.

Shoot and root length per plant (cm): Shoot and root length of five plants from each pot were measured by a scale during harvest and the average value was recorded.

Fresh weight per plant (g $plant^{-1}$): At harvest of five plants from each of the pot, fresh weight of the whole plant was taken by an electric balance and their mean value was calculated as fresh weight expressed in g $plant^{-1}$.

Dry weight per plant (g $plant^{-1}$): Five plants of each pot were collected and oven-dried at 65^0C for 72 hours, weighted in g $plant^{-1}$ by an electric balance and average values were recorded.

Moisture content (%): Percentage of moisture in the plant sample was calculated by using the formula:

$$\text{Moisture content (\%)} = \frac{W_f - W_o}{W_f} \times 100$$

Where,
W_f = Fresh weight of the plant sample
W_o = Oven dry weight of the plant sample

Statistical Analysis

The collected data were compiled and tabulated in proper form and were subjected to statistical analysis. Standard deviation and DMRT (Duncan's Multiple Range Test) were carried out by using computer programs and SPSS version 20.

RESULTS AND DISCUSSION

Red amaranth (*Amaranthus cruentus*) was grown on pots treated with different doses of composted banana and orange peel. The results of the experiment have been presented and discussed as follows:

Number of leaf per plant

The number of leafs per plant ranged from 2.60 to 5.93 (Nos.). The highest number of leaf was 5.93 in 2000 kg ha^{-1} orange compost treated pot (T4) for test crop and lowest 2.60 was found in the control. The results showed that the number of leaf varied significantly among the treatments in respect of control treatment (T0) (Figure 1). The application of composted banana and orange peel have increasing effects on the receiving plants in respect of the number of leaf that varies in different treatments at the order of T4>T3>T2>T1>T0. The highest number of leaf was found in T4 which was treated by orange peel compost. This result is supported by the findings of Khan et al. (2019) where they observed that the use of organic amendments can increase the number of leaves per plant of Red amaranth (*Amaranthus cruentus*). As the use of organic matter enhance the soil fertility as well as improve soil physical properties so the growth of plant including the number of leaf increased by using organic amendments (Brady and Weil, 2008).

Root length per plant

Root length ranged between 2.85 to 4.48 (cm) in red amaranth due to the effect of compost made from fruit peels. The longest root was found in T4 (4.48 cm) when the test crop was treated by 2000 kg ha^{-1} orange peel compost and the shortest was found as 2.85 (cm) in control (T0) (Figure 2). The result showed that root length varied significantly in T2 and T4 and insignificantly in T1 and T3. The root length varied in different treatments at the order of T4>T2>T3>T1>T0. The findings of Farhana et al. (2016) are in support of the findings from current study. They observed that use of organic manures can increase the length of plant roots of water spinach (*Ipomoea aquatica*).

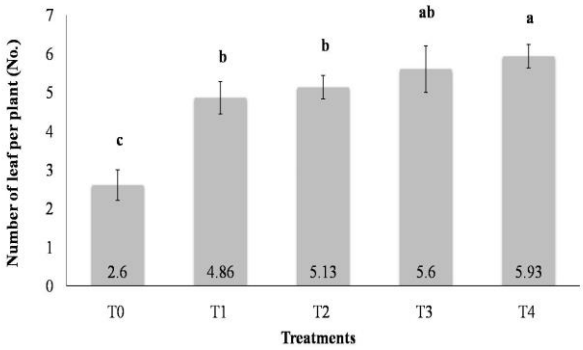

Figure 1. Effect of composted Banana and Orange peel on the number of leaf of Red Amaranth

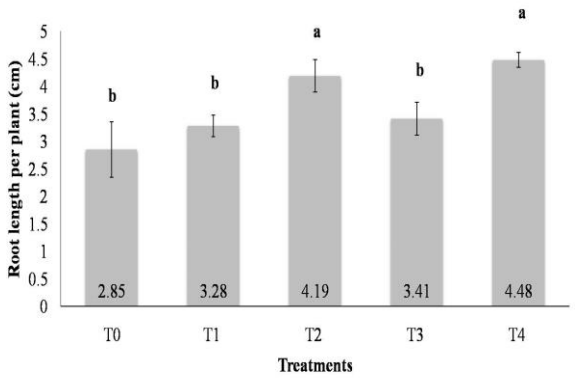

Figure 2. Effect of composted Banana and Orange peel on the root length of Red Amaranth

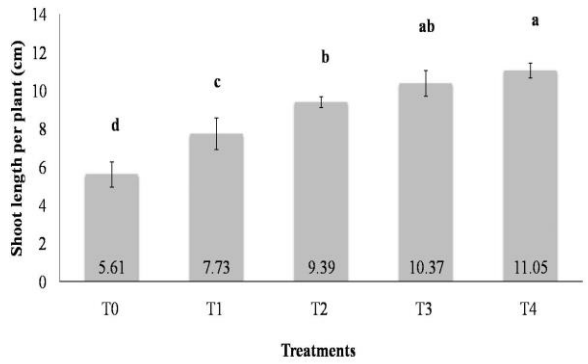

Figure 3. Effect of composted Banana and Orange peel on the shoot length of Red Amaranth

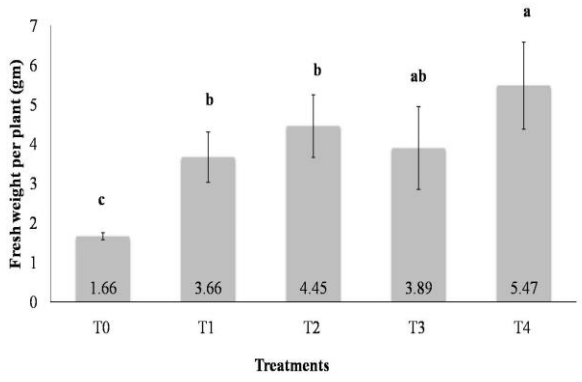

Figure 4. Effect of composted Banana and Orange peel on the fresh weight of Red Amaranth

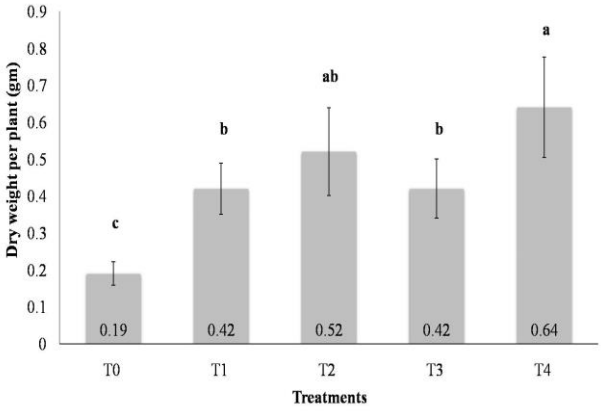

Figure 5. Effect of composted Banana and Orange peel on the dry weight of Red Amaranth

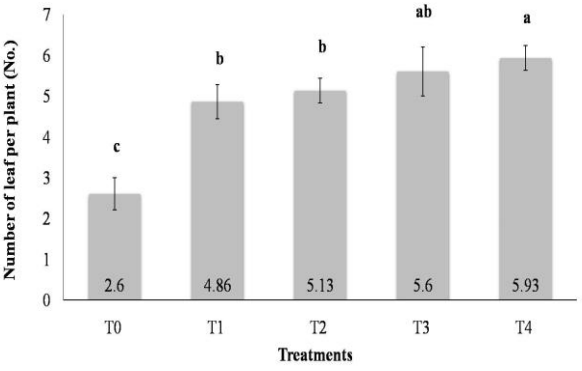

Figure 6. Effect of composted Banana and Orange peel on the moisture content of Red Amaranth

Note: Here, T0= Control (No compost); T1= Banana peel compost (1000 kg ha^{-1}); T2= Orange peel compost (1000 kg ha^{-1}); T3= Banana peel compost (2000 kg ha^{-1}); T4= Orange peel compost (2000 kg ha^{-1}). Bar graph's base value indicates the average. Error Bars indicate the Standard Deviation.

Shoot length per plant

The tallest shoot was 11.05 (cm) in 2000 kg ha^{-1} orange compost treated plants (T4) and the shortest (5.61 cm) was found in the control (T0). The shoot length varied significantly in the treated plants and the control (Figure 3). The applications of composted banana and orange peel have increasing effects on the growth of receiving plants and shoot length per plant. The shoot length varied in different treatments at the order of T4>T3>T2>T1>T0. This finding is supported by the findings of Khan et al. (2019). They observed that shoot length of water spinach (*Ipomoea aquatica*) increased by the application of organic amendment by coconut peat compost.

Fresh weight per plant

Fresh weight was highest in T4 treated plants (5.46 gm) and lowest (1.66 gm) in control (T0). The results showed that fresh weight varied significantly among the treatments in comparison to the control (T0). However, no significant difference was observed between T1 and T3 (Figure 4). The application of composted banana and the orange peel enhanced the growth of receiving plants and fresh weight per plant. Farhana et al. (2016) also observed that fruit waste application in the soil can increase the fresh weight of water spinach (*Ipomoea aquatica*).

Dry weight per plant

Significantly higher dry weight (0.64 gm) was in 2000 kg ha^{-1} orange compost treated plants (T4) and the lowest (0.19 gm) in control (T0). Though, the dry weight varied insignificantly between T1and T3 treated plants. The highest dry weight was recorded in T4 which was treated by orange peel compost. Similar findings were reported by Billah and Saha (2012) while they used organic amendments in their experiment with red amaranth (*Amaranthus cruentus*). They found the use of organic amendments can have positive effects on the dry weight of the plant. Banana peel contains higher amount of Ca, P and K than orange peel but orange peel gave a better result than banana peel which might be due to the presence of other essential nutrients that demands further research.

Moisture content

Moisture content was measured but no significant difference between the treatments was found.

CONCLUSIONS

Compost positively influences the growth and biomass production of crops, especially the leafy vegetables. A test crop, red amaranth (*Amaranthus cruentus*) was grown on soil treated with different doses of composted Banana and Orange peel. These composts release plant's essential nutrients which enhance plant growth and biomass production. As a result, the number of leaves, root length, shoots length, fresh weight, dry weight and moisture content were increased by the application of compost compared to the control. Highest values for the growth parameters were found in T4 (2000 kg ha^{-1} orange peel compost) treated plants. This treatment could be recommended for better harvest from red amaranth (*Amaranthus cruentus*).

Conflict of Interest

The authors declare that there is no conflict of interests regarding the publication of this paper.

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