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Influence of organic liquid fertilizers on growth and yield of *Abelmoschus esculentus*, *Raphanus sativus* and *Amaranthus* spp in container gardening

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***Abstract*—**Use of liquid organic fertilizers is popular among container gardeners in urban areas. The impact of five organic liquid fertilizers (banana waste, weeds, *Gliricidia* leaves, fish waste, and cow dung) Albert's solution (control) on growth and yield of three test crops of *Abelmoschus esculentus*, *Raphanus sativus* and *Amaranthus*spp were studied in the present study. Three separate experiments were laid out as randomized complete block designs with six replicates. The effect of treatments on plant growth and yield of *Abelmoschus esculentus* was significant. Treatment 1, 2 and 3 recorded the greatest fresh weight of pods in okra ($p < 0.0001$). Treatments used in the study significantly influenced the average plant height, fresh weight of leaves, diameter, length and weight of the tuberous root of *Raphanus sativus*. Albert's solution and cow dung liquid fertilizer treated plants produced the tuberous roots with the greatest diameter ($p < 0.0001$) and length (P=0.015) while the plants that received *Gliricidia* leaves liquid fertilizers recorded the least values. Furthermore, the highest and lowest tuberous root fresh was reported by cow dung liquid fertilizer and *Gliricidia* leaves liquid fertilizer, respectively. There was a significant difference between treatments for the average plant height ($p < 0.0001$), number of leaves ($p = 0.0006$), leaf length ($p = 0.03$), leaf width ($p < 0.0001$), stem girth ($p < 0.0001$) and root length ($p = 0.0001$) of *Amaranthus* spp. Nevertheless, the volume of the roots per plant was not significantly different among treatments. As per the results of the present study, it could be concluded that the banana and weeds liquid fertilizer could be used as same as Albert's solution for *Abelmoschus esculentus* while cow dung liquid fertilizer influenced the growth and yield of *Raphanus sativus* in container gardening. Vegetative growth and economic yield of *Amaranthus* spp. can be achieved by applying Albert's solution, banana, weed and fish liquid fertilizers. Selected types of organic liquid fertilizers could be used to replace Albert's solution for short-term vegetable crops. However, the performance of the liquid fertilizer might be affected by the size, shape and colour of the containers used for gardening as well as the quality of the potting mixture.

Keywords*—*Abelmoschus esculentus*, *Amaranthus* spp., organic fertilizers, *Raphanus sativus

I. INTRODUCTION

Reducing, reusing and recycling are the main approaches to waste management, and urban agriculture can perform a significant role in all these approaches (Memon, 2010). Container gardening is one of the components in urban agriculture that occupied the limited spaces in rooftops, backyards, balconies and vertical gardening. Problems related with nutrient-deficient soils and soil-borne diseases can be overcome by switching to container gardening (Pandey *et al*., 2009). The benefaction of container gardening on food security is its main strength while it fulfils an essential fraction of nutritional requirements (Smith and Eyzaguirre, 2007). Sustainable millennium development goals could be reached by introducing urban agriculture concept (Mougeot, 2005). Waste is a source of environmental contaminants and disposal of waste is a global issue. Hoornweg *et al*. (2013) pointed out that globally people discard 3 million tons of waste daily and during the next century; it will exceed more than 11 million tons per day. Under this rubric, urban agriculture and container gardening consist of huge benefits such as reducing waste, improving air quality, social improvement by increasing the quality of life of the urban dwellers, reducing food transport and storage problems, and enhancing ecological diversity (Deelstra and Girardet, 2000). Tomatoes, carrots, lettuce, garlic, cucumber, onions, pepper, and brinjal are commonly grown vegetables that are suited for container gardening with the goal is food production and allow everyone to enjoy the opportunity of gardening (Johnson and Uwex, 2019). Getting a high yield with the application of organic fertilizers with the need for high water and fertilizer use efficiency in container gardening is a challenge (Orsini *et al*., 2013). The use of solid waste such as kitchen and farm waste for container gardening is more common in developing countries (Ali and Porciuncula, 2001). The growing public concern about organic fertilizers has given rise to new government policies and environmentally-friendly decisions to replace inorganic fertilizers with organics in many countries including Sri Lanka. The use of organic liquid fertilizers derived from fish waste, banana waste, weeds, *Gliricidia sepium*, and cow excreta is an environmentally friendly source of fertilizers enriched with local micro-organisms. *Gliricidia* is a kind of protein bank used in the Brazilian semiarid zone (Rangel *et al*., 2019). Present agriculture regards anaerobic digestion of organic waste as an appropriate technology for renewable energy (McCarty, 2001). Organic matter fermentation is a feasible procedure to recover nutrient-rich fertilizers and sustainable waste management. Recent advances in plant-microbe relationship and plant growth-promoting microorganisms have drawn higher attention. These microbes enhance the growth by increasing nutrient acquisition while improving the ability of the plant to survive under abiotic and biotic stress and stimulating plant growth (Lamont *et al*, 2017). Limited recommendations are available for organic fertilizers usage as they are varying in their nutrient composition and mineralization rate (Masunga *et al*., 2016). Hence, identifying a precise rate of application is important (Mbatha, 2008). The selection of suitable crop species and the use of the appropriate amount of organic fertilizer are critical factors for getting high yields from crops in container gardening (Chapagain *et al*., 2010). It is important to focus on organic nutrient management along with an appropriate species selection of vegetables for container gardening as with the increased population this has an important contribution to dietary adequacy and creating sustainable cities in the future (Brown and Jameton, 2000).

The purpose of the present study was to examine the suitability of different organic liquid fertilizers on the growth and yield of three test crops of *Abelmoschus esculentus*(okra), *Raphanus sativus* (radish) and *Amaranthus* spp (thampala). The selected test crops have different growth patterns and their economic yield varies significantly. The fruit of *Abelmoschus esculentus*, tuberous root of *Raphanus sativus* and fresh leaves of *Amaranthus* spp are economically important and the nutrient requirements of these three crop species are different Gopalakrishnan (2007).

II. Methodology

A. Experimental site and location

Three experiments were conducted in an urban garden located in Kurunegala district (IL1) (7.4900° N, 80.2423° E) from May to October 2021. The average light intensity and the daily temperature of the urban garden were 60,000 lux and 32°C, respectively.

B. Preparation of organic fertilizers

Five types of liquid organic fertilizers and synthetic liquid fertilizers (T1- Albert's solution, T2- Banana waste fermentation with rice washing water plus brown sugar, T3- weed fermentation with yogurt, T4- Gliricidea leaves fermentation with freshly produced compost and cow dung, T5- Fish waste fermentation with raw papaya and jaggary, T6- cow dung and cow urine fermentation with jaggary) were used as the treatments in the experiments. Albert's solution as the source of synthetic liquid fertilizer was prepared by diluting 10 g of granules in 4.5 liters of clean water according to the standard recommendations. Albert's solution is arich source of nitrogen (10.5%), Phosphorous (9.1%), potassium (16.4%), magnesium (0.86%), calcium (9.5%), and many micronutrients in appropriate ratios for vegetables, fruits and flowers (Ranasinghe and Weerakkody, 2006).

For the preparation of banana waste organic fertilizer, one kg of a banana hump, leaves, banana peels and fruit waste (1:1:1:1w/w) were chopped into small pieces after being washed. Five liters of rice washed water and 500 g of brown sugar were added to a 10 liters bucket with banana waste and kept for fermentation after tightly closing the lid. The fermented product was filtered after 21 days and diluted 1:5 (V/V, volume basis) with water before applying it to the plants. Roeswitawati and Ningsih, (2018) also developed an organic fertilizer with the use of chopped banana hump and fruit waste with the addition of rice-washed water and molasses. Pangaribuan *et al*. (2019) prepared banana organic fertilizer from banana humps, brown sugar, rice washing water and effective microorganism (EM-4) and kept three weeks for fermentation.

One kg of chopped fish waste was added to a 15 liters volume container as the main raw material for the preparation of fish waste organic fertilizer. Fish wastes have the potential of supplying a combination of nitrogen and phosphorous for horticulture plants. Ahuja *et al*. (2020) have certified that the anaerobic digestion of fish waste was applicable for organic farming. Simultaneously, 250 g of sliced raw papaya and jaggery pieces were added and mixed well. After proper blending, 250 ml of clean water was added to the mixture and allowed to ferment for two months by tightly closing the lid of the container. Fermented fish waste was applied to plants by diluting with clean water with 1:30 (v/v) ratio (Ekanayake *et al*., 2020). Fermented weeds organic fertilizer was prepared by mixing 1 kg of sliced weeds; Lantana camara, Mimosa invisa, and Mikania micrantha(1:1:1w/w) and 250 g of yogurt and 500 ml of clean water. The mixture was kept for 21 days for fermentation after closing the lid tightly. Fermented weeds organic fertilizer was applied to plants after filtering and diluting with clean water by 1:2 (v/v) ratio.

Similarly, *Gliricidia* leaf fertilizer was prepared by mixing 1 kg of immature *Gliricidia* leaves and 250 g of fresh cow dung, and a handful of newly prepared matured compost as a source of microorganisms. Fermentation was allowed for 21 days and *Gliricidia* leaf organic fertilizer was applied after filtering and diluting with clean water by 1:2 (v/v). Gunaseelan, (1988) has found that the anaerobic digestion of *Gliricidia* leaves was better in quality than the raw *Gliricidia* leaves as an organic manure for plant growth. For the preparation of cow dung organic liquid fertilizer, 2 kg of native cow dung, 1 liter of native cow urine, and small pieces of 250 g jaggery were mixed. The mixture was added to a 15 liters plastic bucket and kept for 21 days until the fermentation process was over. Fermented cow dung organic fertilizer was applied after diluting with clean water by a 1:2 (v/v) ratio. Safitri *et al*. (2019) used cow urine:

sugar: organic waste with cow dung in the ratio of 4:1:1 and found fermented cow excreta organic fertilizer contains a high content of nitrogen and ammonia that is utilized by plants effectively. All these fermentations were carried out in dark conditions under shade. Electrical conductivity (EC) and pH of all fermentations pH were maintained in the range of 5- 7 and 0.5- 1.5 dS/cm3, respectively. A correctly fermented product was identified by its translucent coloring, the presence of whitish foam, and the nonexistence of visible solid elements. There was a distinct smell similar to silage and the consistency of an optimally fermented slurry .The length of the fermentation process change with the climate, such that two weeks in a hot climate and eight weeks in a cold climate (Chen *et al*., 2011). Bluish or green coloring with a turbid appearance, a putrid smell, and the presence of fungi are the signs of incorrect fermentations. Three separate experiments were conducted to evaluate the effect of liquid organic fertilizers on growth and yield of test crops of *Abelmoschus esculentus* (okra), a vegetable-produced edible fruit, *Raphanus sativus* (radish), a root vegetable and *Amaranthus* spp., a leafy vegetable. Experiments were set up according to randomized complete block design with six replicates due to the effect of shade of large trees. The potting mixture was prepared with sand: topsoil: coir-dust: and compost in a 1:1:1:1/4 ratio. Seeds of okra (Variety: MI-5) were sown in thirty-six pots of 20 cm in diameter and 10 liters in capacity. Fertilization was commenced two weeks after establishment and 200 ml of liquid fertilizer was applied every three days until the harvesting stage. Plant height, stem girth at 5 cm above the soil level and the number of leaves, number of pods per plant, pod girth, and length were calculated at the fruiting stage while the total fresh okra pod weight per plant was calculated by getting the cumulative value of pods to harvest for two months. For radish (Variety: Long), same-sized, and aged with similar vigor radish seedlings were selected from a nursery tray filled with the mixture of topsoil: sand: compost; 1: 1: 1. Two weeks old seedlings were transplanted in thirty-six pots of 20 cm diameter filled with the potting mixture similar to the previous experiment. Fertilization was started two weeks after transplanting radish seedlings and treated with 150 ml of organic liquid fertilizerper pot in three days intervals. The number of leaves per plant, leaf width, fresh leaf weight, tuber diameter, length and fresh weight of tuber were measured after two months. Seeds of *Amaranthus* (variety: Red) were sown in pots of 20 cm diameter bulking with sieved river sand. After 2 weeks, *Amaranthus* seedlings were thinned by remaining one healthy seedling per pot and started the fertilization procedure. A volume of 200 ml of organic and inorganic liquid fertilizers was applied in three days intervals up to the harvesting stage. Mean plant height, the number of leaves, leaf length and width, stem girth, root length and volume, and total above-ground fresh weight were recorded after two months.

C. Statistical analysis

III. Results and Discussion

The average plant height, stem girth, number of leaves and pods per plant, pod girth, and length were significantly different among treatments ($p < 0.001$). The tallest plants, greatest stem girth, the highest number of leaves and pod length were recorded in T1 treatment (Table 1). The shortest plants were observed in T4, T3 and T6 treatments. The lowest stem girth was observed in T4. T4, T3 and T5 treated okra plants showed the lowest number of leaves per plant. The greater number of pods per plant was recorded in T1, T2, T3 and T6 treatments. Girth of the pods in T1, T2 and T3 was similar to each other.

Similar fresh weights of okra yield per plant were observed in T1, T2 and T3 while they were not significantly different from each other (Figure 1). T4 showed the lowest okra yields in the present study. Supporting our findings, Iqram and Seran (2016) revealed that the tallest plants, the highest number of branches, number of fruits, and fresh weight of fruits per plant in tomato were observed in the foliar application of 2 g/l Albert's solution and also Albert treated plants increased their pulp, seed weight, leaves, stem, and roots dry weights with total soluble solids. Similarly, banana humps and waste are prominent sources of macronutrients such as nitrogen, phosphorus and potassium (Pangaribuan *et al*., 2019). Moreover, banana hump peels and fruit wastes are the major sources of Gibberellin and Cytokinin (Ulfa *et al*., 2013). Rice washing water consists of various types of minerals and vitamins (Abba *et al*., 2021). Banana liquid fertilizer can be enriched by adding rice washing water. Sari*et al*. (2020) reported the potential of using banana liquid organic fertilizer as a hydroponic fertilizer for Brassica rapa L. Molasses and sugar are the sources of carbohydrates for the microbes to grow and microorganisms are effective in the rapid decomposition of organic materials. Furthermore, brown sugar and molasses are the primary sources of potassium, phosphorus, Sulphur, calcium and magnesium together with ahigh number of trace elements. Molasses and brown sugar improve soil aggregation and avoid surface crusting (Wynne and Meyer, 2002). Brown sugar is a sulfured source of bio-organic fertilizer riches with phosphorus solubilizing bacteria favorable for plant growth (Roslan *et al*., 2021).

In the context of weeds organic fertilizer, Mimosa invisa has the potential to use as green manure and compost due to its high rate of dry matter accumulation, nitrogen fixation ability with high nutrient content and rapid decomposition rate (Jayasree and Abraham, 2007). Fermented weed juice was tested on the growth and yield of okra, thampala, and radish by Yusop *et al*., (2013) who prepared a fermented weed juice using *Amaranthus* spinonsus, Chromolaena odora, and Asystasia gangetica mixed with brown sugar, showed a high growth and yield in Luffa acutangula. Compost produced from Mimosa invisa contains 2.35 % nitrogen, 0.13% P2O5 and 0.41 % K2O (Barman *et al*., 2007). For weed fermentation, yoghurt was added as a source of microorganisms

Table I: The effect of treatments on growth and yield parameters of okra (Abelmoschus esculentus).

Treatment	Plant height at fruiting stage (cm)	Stem girth at fruiting stage (cm)	Number of leaves per plant	Number of pods per plant	Girth of pods (cm)	Length of pods (cm)
T1	104.2^{a}	9.3^{a}	17.3^{a}	20.3^{a}	6.4^{a}	20.3^{a}
T2	101.2^{b}	8.5^{b}	16.3^{b}	19.7^{a}	6.3^{a}	19.7^{b}
T3	98.7^{c}	8.2^{bc}	15.7^{bc}	18.8^{ab}	6.2^{a}	19.6^{b}
T4	98.0^{c}	7.3^{d}	14.8^{c}	17.0^{b}	5.2^{c}	18.5^{c}
T5	100.8^{b}	8.3^{bc}	15.5^{bc}	16.8^{b}	5.8^{b}	18.9^{c}
T6	99.8^{bc}	8.1^{c}	16.2^{b}	19.0^{ab}	5.7^{b}	19.0^{c}
P value	<0.0001	<0.0001	<0.0003	<0.0001	<0.0001	0.028
CV%	1.58%	3.35%	4.85%	10.76%	1.97%	2.14%

(Means with similar letters are not significantly different from each other in =0.05), (T1- Albert's solution, T2- Banana liquid fertilizer, T3- weeds liquid fertilizer, T4- Gliricidia leaves liquid fertilizer, T5- Fish waste liquid fertilizer, T6- cow dung liquid fertilizer) significance level = 0.05 (df=5)

for effective decomposition, and Lamont *et al*. (2017) proved that yogurt waste can optimize microbial growth during composting. Ferments containing lactic acid bacteria can improve soil, control diseases, and promote plant growth. As organic fertilizers, yoghurt can improve nutrient availability in weed fermentation. Recently found that yoghurt effectively promotes seed germination, and diminishes various abiotic stresses in different plant species (Lamont *et al*., 2017). Tong *et al*. (2011) tested weed fermentation prepared from (Artemisia princeps, Ranunculus japonicus, and Stellaria media (Linn.) and found that all three weed fermentations stimulated the growth of pomelo seedlings and described that there was a huge growth stimulatory effect in fermented weeds and no matter which kind of weeds were used for the fermentation. Lantana camara, Mimosa invisa, and Mikania micrantha weed species were considered invasive alien weeds with high adaptability to broad environmental conditions and prolific reproducing habits. Production of organic fertilizers from alien weeds is a managing strategy for controlling and eradicating unwanted weeds (Raj and Syriac, 2016).

Although *Gliricidia* organic fertilizer contains a comparatively high nitrogen content of about 3.65% than fruit waste, banana weevil waste, vegetable waste, cow manure and urine (Riyanto, 2021), nitrogen supplied from *Gliricidia* was very quick and readily available for the plants than other organic fermentations. Mundus *et al*. (2008) showed that the decomposition rate of *Gliricidia* leaves is twice that of cattle manure, and found that the decomposition rate of *Gliricidia* was 2.5 times faster than surface application when the materials were incorporated with soil. Dubey *et al*. (2015) emphasized the importance of using immature *Gliricidia* and fodder for composting and fermenting than mature leaves as they decompose quickly at any depth depending on the prevailing weather. But low K content in the potting media may negatively impact on absorbing nitrogen from *Gliricidia* due to complexes formed with K which causes the release of nitrogen. Hence, *Gliricidia* leaves need combination with NPK to release nitrogen to the plant media (Akande *et al*., 2010) and this may be the reason for reducing growth parameters in okra treated with *Gliricidia* liquid fertilizer.

The plant height, the number of leaves per plant, leaf

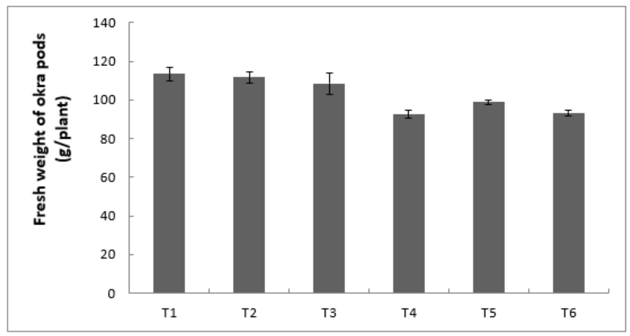

Figure 1: Effect of different organic treatments on the fresh weight of okra pods. (T1- Albert's solution, T2- Banana liquid fertilizer, T3- weeds liquid fertilizer, T4- *Gliricidia* leaves liquid fertilizer, T5- Fish waste liquid fertilizer, T6- cow dung liquid fertilizer) Error bars represent the SE of means

width and weight, diameter of tuberous root, and lengths were significantly influenced by six treatments ($p < 0.001$). The greatest radish plant height was observed in T6, T1, T2, and T5 (Table 2). The shortest plants were observed from T3 and T4 treatments. In the present study, a similar number of leaves per plant and leaf width were given by all six treatments and hence there was no significant difference among the treatments.

T1, T2, T3, T5, T6 recorded the highest leaf width. The greatest diameter and length of tuberous of radish was observed in T6 and T1 treatments Cattle manure is the most common organic source of nutrients frequently used for organic fertilizer preparation. Fresh dung is not only a source of nutrients but also of favorable microbes needed for the fermentation process including yeasts, fungi, protozoa, and bacteria inoculums. Fine-tune with our results, Li, *et al*. (2011) showed that fermentation of cow manure was one of the options for efficient fertilizer production, and sustainable waste management, which increase crop productivity in an eco-friendly and cost-effective way than using chemical fertilizers. According to Uka *et al*. (2013), the applications of cow dung, poultry manure, and synthetic fertilizer have a significant effect on all the growth parameters in okra and cow dung application gave the highest dry weight in okra plants and the application of organic manure in the production of vegetables was encouraged.

T6 and T1-treated radish plants recorded the highest tuberous root fresh weight while the lowest fresh tuberous root weight was observed in T3 and T4 (Figure 2). Supporting present experimental results, Kumar and Gupta (2018) found that the growth parameters such as plant height, the weight of the tuberous root, stem diameter, fruits per plant, and dry matter yield of radish were high in vermicompost and cow dung than urea application. The maximum values of plants height, number of leaves per plant, leaf size, leaves weight per plant, leaves yield, root size, individual root weight, root yield, and dry matter in *Raphanus sativus* were found in 25 t ha-1 application of poultry manure and the second highest was observed in 40 t ha-1 cow dung application (Uddain *et al*., 2010). Similarly, Shaheb *et al*. (2015) found that the highest root yield of radish (45.60 t ha-1) was recorded from cowdung bio-slurry applied at the rate of 5 t ha-1 along with inorganic fertilizer. Animal manure is identified as a low-cost and environmentally friendly alternative to inorganic mineral fertilizers that enhance crop growth and yield by providing large amounts of macro and micronutrients. Post-harvest soil analysis indicated that there were no significant changes in soil organic matter, soil pH and other nutrients due to the application of the bio-slurry of cow dung (Shaheb *et al*., 2015).

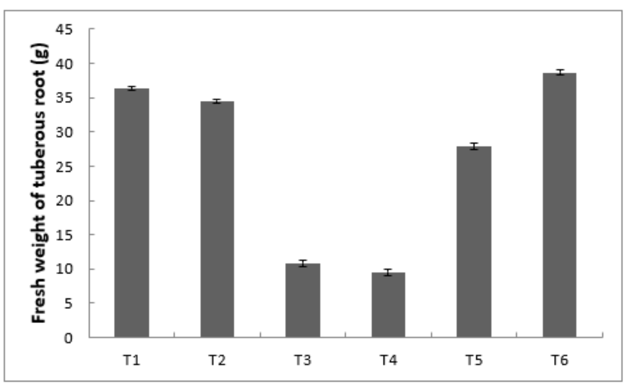

Figure 2: Effect of different organic waste fermentation and inorganic liquid fertilizer on the fresh weight of radish tubers. (T1- Albert's solution, T2- Banana liquid fertilizer, T3- weeds liquid fertilizer, T4- *Gliricidia* leaves liquid fertilizer, T5- Fish waste liquid fertilizer, T6- cow dung liquid fertilizer) Error bars represent the SE of means

The highest average plant height was observed in T1, T2 and T 5 treated plants. However, stem girth was high when treated plants with T1 and T5. The greatest number of leaves was recorded in T1, T2, T3 and T5 treatments. The leaf length and width were not significantly different in T1, T2, T3 and T5 treatments. The grater root length was observed in T5 and T6 treatments. The root volume per plant of *Amaranthus* was not significantly different among treatments (Table 3). Root growth is highly responsive to variations in the distribution of nutrients in the potting media. Mainly N, P, K, and Fe improve root growth and alter root branching, lateral root initiation, root diameter, and root formation. The nutrient composition can, directly and indirectly, effect on root development process (Forde *et al*, 2001). Root dimensions such as the number of lateral roots, root lengths, and diameters are crucial to realizing nutrient uptake dynamics in plants (Zobel *et al*., 2007). Lack of optimum nutrients in the T4 and T6 may be the ground cause for increasing root lengths in *Amaranthus* plants. But in contrast, the root volume of *Amaranthus* was not significantly different among all six treatments.

The highest fresh weight of *Amaranthus* plant was recorded in T1, T2, T3, and T5 while T4 and T6 presented the lowest fresh weight. Ekanayake *et al*. (2020) proved that application of 10 grams diluted in 4.5 liters of water Albert's solution showed the highest yield of Centella asiatica. However, according to the present study, effect of most of the organic liquid fertilizers is similar to the Albert's solution. Collaborate with our research findings, banana peels were prominent sources of minerals such as sodium, iron, manganese, potassium, calcium, bromine and rubidium, and proved that banana peels were high in carbohydrates and minerals which can effectively use for composting (Anhwange *et al*., 2009).

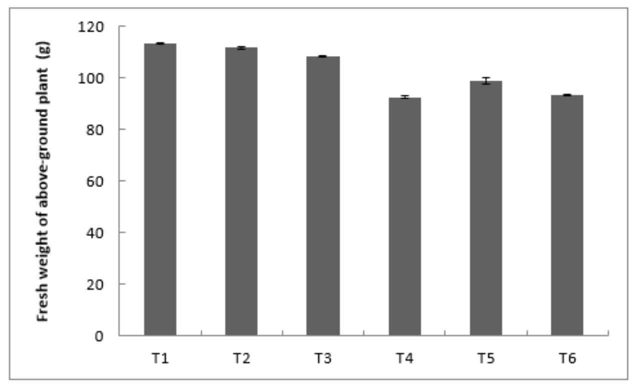

Figure 3: Effect of different treatments on the fresh weight of the above-ground part of the *Amaranthus* plant. (T1- Albert's solution, T2- Banana liquid fertilizer, T3- weeds liquid fertilizer, T4- *Gliricidia* leaves liquid fertilizer, T5- Fish waste liquid fertilizer, T6- cow dung liquid fertilizer) Error bars represent the SE of means

IV. Conclusion

Organic liquid fertilizers produced from banana waste and weeds showed positive effects on the growth and yield of *Abelmoschus esculentus*, indicating the ability to use the same as the inorganic liquid fertilizer (Albert's solution) in container gardening. For tuber growth of *Raphanus sativus*, cow dung fertilizer was found to have a better yield than liquid chemical fertilizer. Organic fertilizers from banana waste and weeds showed similar yield potential as synthetic fertilizer in *Amaranthus* yield. Further, banana and weeds fertilizers can introduce for *Abelmoschus esculentus* and *Amaranthus* while cow dung fertilizer for *Raphanus sativus* can introduce a package for container gardening, while these three organic fertilizers can be used effectively instead of Albert's solution. However, the effect of different fertilizers on the growth and yield of the vegetables tested in the present study could be significantly influenced by the size, volume, and color of the containers used.

Table II: The effect of treatments on growth and yield parameters of okra (Raphanus sativus)

Treatments	Plant height (cm)	Number of leaves per plant	Average leaf width (cm)	Leaf weight per plant (g)	Tuber diameter (cm)	Tuber length (cm)
T1	36.47^{a}	13.0^{a}	7.03^{a}	104.17^{a}	9.0^{a}	10.83^{a}
T2	36.18^{a}	12.2^{a}	7.05^{a}	103.00^{a}	7.6^{b}	9.05^{bc}
T3	16.95^{b}	12.8^{a}	6.82^{a}	99.33^{a}	2.1^{d}	3.25^{d}
T4	16.50^{b}	11.8^{a}	7.00^{a}	94.17^{b}	1.8^{d}	2.43^{d}
T5	36.17^{a}	12.7^{a}	7.02^{a}	99.83^{a}	6.7^{c}	7.83^{c}
T6	37.87^{a}	12.4^{a}	7.10^{a}	103.50^{a}	9.5^{a}	9.80^{ab}
P value	<0.0001	0.03	0.001	0.003	<0.0001	0.015
CV%	5.73%	7.2%	3.15%	4.2%	7.9%	16.26%

(Means with similar letters are not significantly different from each other in =0.05), (T1- Albert's solution, T2- Banana liquid fertilizer, T3- weeds liquid fertilizer, T4- *Gliricidia* leaves liquid fertilizer, T5- Fish waste liquid fertilizer, T6- cow dung liquid fertilizer) significance level = 0.05 (df=5)

Table III: The effect of treatments on growth parameters of Amaranthus spp.

Treatments	Plant height	Stem girth	Number of leaves	Leaf length	Leaf width	Root length	Root volume
T1	95.53^{a}	5.87^{a}	74.50^{a}	7.95^{a}	6.93^{a}	38.22^{b}	25.33^{a}
T2	87.98^{ab}	5.02^{b}	69.67^{a}	7.52^{ab}	6.75^{a}	39.25^{b}	21.67^{a}
T3	86.83^{b}	4.95^{b}	68.18^{ab}	7.33^{ab}	6.50^{a}	38.28^{b}	22.33^{a}
T4	68.72^{c}	3.40^{c}	58.50^{c}	6.60^{b}	5.35^{b}	45.57^{a}	22.17^{a}
T5	88.58^{ab}	5.43^{ab}	72.00^{a}	7.25^{ab}	6.47^{a}	37.80^{b}	24.17^{a}
T6	69.10^{c}	3.30^{c}	62.33^{bc}	6.83^{b}	5.60^{b}	46.15^{a}	23.33^{a}
P value	<0.0001	<0.0001	0.0006	0.03	<0.00001	0.0001	0.057
CV%	7.82%	10.49%	7.79%	10.75%	7.95%	8.23%	14.35%

(Means with similar letters are not significantly different from each other in =0.05), (T1- Albert's solution, T2- Banana liquid fertilizer, T3- weeds liquid fertilizer, T4- *Gliricidia* leaves liquid fertilizer, T5- Fish waste liquid fertilizer, T6- cow dung liquid fertilizer) significance level = 0.05 (df=5)

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