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Effect of Powdered and Composted Meat Bones on the Growth and Yield of Water Spinach (*Ipomoea aquatica*)

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Abstract: For agriculture, the most important is the soil's function as a base and medium for plant growth. The soil health and soil condition are important for plant growth. And the management of soil organic matter is an important part in case of managing soil health and maintaining soil conditions. The experiment was carried out in the field lab (Net House) of Soil, Water and Environment discipline, Khulna University, Bangladesh. Total 21 plastic pots were used to continue the experiment with 7 treatments. For the experiment, the meat bones were collected and used in the experimental pot along with soil in different doses. This research has revealed that meat bones both powdered and composted, has significantly increased (about 20-25%) the growth parameters of water spinach (*Ipomoea aquatica*) such as a number of leaves, shoot length, fresh weight, dry weight and moisture content. So, the application of powdered and composted meat bones in soil will contribute in the growth of water spinach (*Ipomoea aquatica*).

Keywords: Meat bones; Soil Organic Matter; Pot experiment; Water spinach (*Ipomoea aquatica*)

I. INTRODUCTION

Agriculture is the most important sector of the economy of Bangladesh, contributing about 23% of the country's GDP and employing about 62% of the total labour force. Bangladesh,

after independence, has adopted various measures to raise vegetable production for tackling the malnutrition problem in the Bangladesh.

Water spinach (*Ipomoea aquatica*) also known as 'kalmi shak' (in Bengali) is one of the popular vegetables that is promoted to grow in Bangladesh due to its good nutritive value, antioxidant properties, high fiber content and many other health-related benefits (Hongfei, 2011; Kala and Prakash, 2004; Faruq *et al*., 2002; and Ogle *et al*., 2001). It is a vascular semi-aquatic herbaceous perennial plant belonging to *Convolvulaceae* (USDA, 2005). Water spinach, *Ipomoea aquatica* Forssk. (Convolvulaceae), is an aquatic or semi-aquatic edible herb (Dua *et al*., 2015). It has a hollow and viny stem, grows prostrate or floating, and roots are coming from the nodes that penetrate the soil. Water spinach is native to the tropics and subtropics of Southeast Asia, Southern China and India (Gothberg *et al*., 2005 and Chen *et al*., 1991). It is a green vegetable and is ranked high among the world's healthiest foods, and there are plenty of reasons for it being so. It is one of the ideal options to manage weight and to lower the cholesterol levels. It consists of rich amounts of iron that is required by the red blood cells during process of hemoglobin formation. So, people who are suffering with anemia should include their diet with this iron rich leafy vegetable (Gupta *et al*., 2005).

Figure 1: Water spinach

For agriculture, the most important is the soil's function as a base and medium for plant growth. Soil health and soil condition is important, and the management of soil organic matter is an important part of managing soil health and maintaining soil condition. Most of the soils of Bangladesh have low organic matter content, usually less than 2% (Bhuiyan, 1994). A good soil should have at least 2.5% organic matter, but in Bangladesh, most soils have less than 1.5%, and some soils have even less than 1% organic matter (BARC, 2005). The pressure on the management of soil organic matter is increasing as costs of inputs for agriculture increase and the capacity and ability to overcome soils in poor condition by adding more fertilizer, adding one more cultivation, adding one more irrigation or adding another input are diminished (MacEwan, 2007).The ultimate source of organic matter for most soils is through the fixation of carbon dioxide from the atmosphere through photosynthetic reactions by plants. There is also a very small input from autotrophic bacteria. However, in some instances, there may also be some input from industrial and mining products derived from petroleum or coal. At the broad scale, these sources of soil carbon are

insignificant. Soil organic matter is derived from organic materials that are added to the soil, and the majority of soil organic matter derives from the breakdown of residues remaining after plants have died. These residues can take the form of root residues located in the soil matrix or leaves, stems and stubble existing as litter on the soil surface. Animals also provide a proportion of the soil organic matter to varying degrees depending on management and the ecosystem (Tate, 1987). Additions of large amounts of organic materials as composts or as biochar can increase the levels of soil organic matter in soils (Gibson *et al*., 2002). Soils are used as a filter or sink for effluent and waste materials. The wastes produced from meat bones can be used as such types of organic materials as the replacement of compost or fertilizers. Maximum people eat various types of meat daily. There are some particular occasions such as wedding ceremony, some religious festivals like Eid, Puja etc which is incomplete without meat. A lot of meat bones can be found after these ceremonies. If we use these bones as fertilizers for plant growth, then the waste load will be controlled. Usually, beef bones, however, other types of a creature like chicken or pigeon bone meal or emulsion can be used to prepare meat bone fertilizer. The processed bone meal goes through to become a powder or compost will quickly kill off many pathogens.

Meat and bone meal (MBM) can be a viable alternative to mineral fertilizers because it contains about 8% Nitrogen (N), 5 % Phosphorus (P), 1 % Potassium (K) and 10 % Calcium (Ca) (Ylivainio *et al*., 2007), which makes it a valuable source of nutrients for plant production. It has about 50% protein, 35% ash, 8-12% fat, and 4-7% moisture, and contains a big amount of nutrients. Chemical properties of Meat Bone Materials (MBM) vary a lot from different raw materials. On average, the pH tends to be acidic, about 6.5. Organic matter in content is about 50% (Jeng *et al.*, 2006). Besides a great deal of phosphorous, bone meal also provides smaller amounts of essential nitrogen, potassium and calcium. As the bone meal breaks down over the season, it will steadily and slowly release these nutrients for plant uptake. The advantageous aspects of slow release nutrition are that plant roots will not burn, and that soil vitality is increased for extended periods (Cayuela *et al.*, 2009).

Objectives

- ⇨ To minimize the rate of waste load by using the meat bones as organic fertilizer which is environmental friendly as well as to improve soil health
- ⇨ for determining the effectiveness of different types of meat bones in water spinach cultivation
- ⇨ To assess the effect of composted and powdered meat bones on the growth and yield of water spinach (*Ipomoea aquatica).*

II. METHODS AND MATERIALS

Location of the study area

The experiment was carried out in the field lab (Net House) of Soil, Water and Environment discipline, Khulna University, Bangladesh.

Collection and preparation of the soil

The soil for our research was collected from the research field of Soil, Water and Environment Discipline, Khulna University. Spade, plastic bag was used for collecting the soil. Then the soil was air dried at room temperature, and all the plant debris were removed manually. Then the massive aggregates were broken by gentle crushing by a hammer. Then the soil was sieved by 2mm sieve.

Preparation of pot

After sieving, the soil was taken into pots for sowing the seeds. Total 21 plastic pots were used to continue the experiment. The pots were cleaned and labelled. Each Pot was filled with 3kg sieved soil. Pots had no pore in its bottom to protect the leaching of meat bone fertilizers from the soil. The experiment was started on 24th June, 2018.

Powdered and composted meat bones preparation

The meat bones were collected after eating. Then some of the bones were crushed into powder form with the help of crusher (Haman dista). To prepare meat bone compost, bones (pigeon, chicken, and beef) were crushed and transferred it into a plastic bag. Sufficient amount of water was added into it to degrade the meat bones and kept it by digging soil into 30cm depth. After 60 days (4th June – 4th August), the compost was ready to be applied into my experiment. 10g powdered and composted meat bones were applied to each pot. 5g was mixed up with the soil before sowing the seeds, and the rest 5g was added when the seeds were grown up to plants.

Treatments of investigation

Seven treatments were used in the experiment.

T_0 = Control
T_1 = 500 kgha^{-1} powdered beef bone
T_2 = 500 kgha^{-1} powdered chicken bone
T_3 = 500 kgha^{-1} powdered pigeon bone
T_4 = 500 kgha^{-1} composted beef bone
T_5 = 500 kgha^{-1} composted chicken bone
T_6 = 500 kgha^{-1} composted pigeon bone

Sowing of the seeds

The seeds were sown on 24th June, 2018.The seeds were sown thoroughly as it was possible to keep uniformity and then the seeds were covered by soils. 0.01 g seeds (5 kg ha^{-1} as recommended by BARI, 2005 for trial experiment) were sown in each pot and maximum seeds germinated within 5 days. After germination only five plants were kept in each pot.

Figure 2: Sowing the seeds of water spinach

Intercultural operations

Watering

For normal plant growth, the water was added regularly (2-3 days intervals) to each pot for maintaining enough moisture.

General observation

The pots under experiment were frequently observed to note any change in the crop growth and other characteristics. The crop growth was very satisfactory in some treatments. But some treatments showed a lower number of plants.

Harvesting

The experimental crops were harvested after 40 days of germination. The harvested plants were tagged separately, weighted, oven dried at 65^0C temperature for 24 hours until moisture content reached to a minimum condition. The dried material of plants per pot from each treatment was collected.

Number of leaves

The number of leaves of five plants of each pot was counted and average value was taken.

Shoot length (cm)

Shoot length was measured using a measuring scale from the root level to the tip of the plant. From each pot, five plants were measured and averaged.

Root length (cm)

Root length was measured using a measuring scale from root level to the tip of the longest root at harvest, and their average value was taken as the root length in cm.

Fresh weight per plant (gm)

Harvest of five plants from each pot, fresh weight of the whole plant was taken by an electrical balance, and their mean value was calculated as fresh weight expressed in gm/plant.

Dry weight per plant (gm)

Five plants from each pot were collected and oven dried at 65^0C for 48 hours, weighed in gm/plant by an electrical balance and average value was recorded.

Moisture content (%)

Percent moisture was calculated by using the formula:

Moisture content (%) = $\frac{Wf-Wo}{Wf} \times 100$

Where,

W_f = Fresh weight of the plant sample

W_o= Oven dry weight of the plant sample

Statistical analysis

The collected data on different parameters were represented in bar diagram by Microsoft office excel program 16.0 and statistically analyzed following the analysis of variance (ANOVA) technique. Statistical analysis was performed by using MINITAB 18 statistical package. The Completely Randomized Design (CRD) was followed as experimental design and the different doses of meat bones in composted and powdered forms were the treatments.

III. RESULTS AND DISCUSSIONS

Effect of powdered and composted meat bone on the growth and yield of Water spinach (*Ipomoea aquatica*) was studied following pot experiment. The number of leaves per plant, shoot length per plant, root length per pant, fresh weight per plant, dry weight per plant and percent moisture content were measured for the plants treated with 10g powdered and composted meat bone and compared with plants grown with no meat bone which was control experiment. The data of morphological attributes are presented in Table 1.

Table 1: Observed growth factors of the experimented water spinach for different treatments

Treatments	No. of leaves /plant	Root length /plant (cm)	Shoot length /plant (cm)	Fresh weight /plant (g)	Dry weight /plant (g)	Moisture content (%)
T_0	8	8.81	17.64	1.09	0.08	64.36
T_1	9	9.31	24.32	1.56	0.37	76.49
T_2	9	9.98	24.25	1.23	0.32	73.85
T_3	8	10.93	18.65	1.17	0.35	70.25
T_4	9	12.65	22.01	2.67	0.40	84.97
T_5	11	13.51	24.96	3.47	0.52	85.05
T_6	10	13.91	23.93	3.30	0.48	85.39

1. Number of leaves per plant

The number of leaves of water spinach was significantly influenced by different treatments in maximum cases. The highest number of leaves was found in T_5 (10.73) (Table 1). The results exhibited that there was the insignificant difference in T_1, T_2, T_4 and T_6 compared to the control experiment T_0 and a significant difference was found in T_3 and T_5 (Figure 3).

Application of composted chicken bone showed a significant increment of the number of leaves in water spinach, whereas application of other meet bone fertilizers did not show any positive effect on the number of leaves of water spinach. On the basis of the number of leaves of plants, application of composted chicken bone is the best for using, and it is recommended to use as a soil amendment for the growth of such type of leafy vegetables like water spinach.

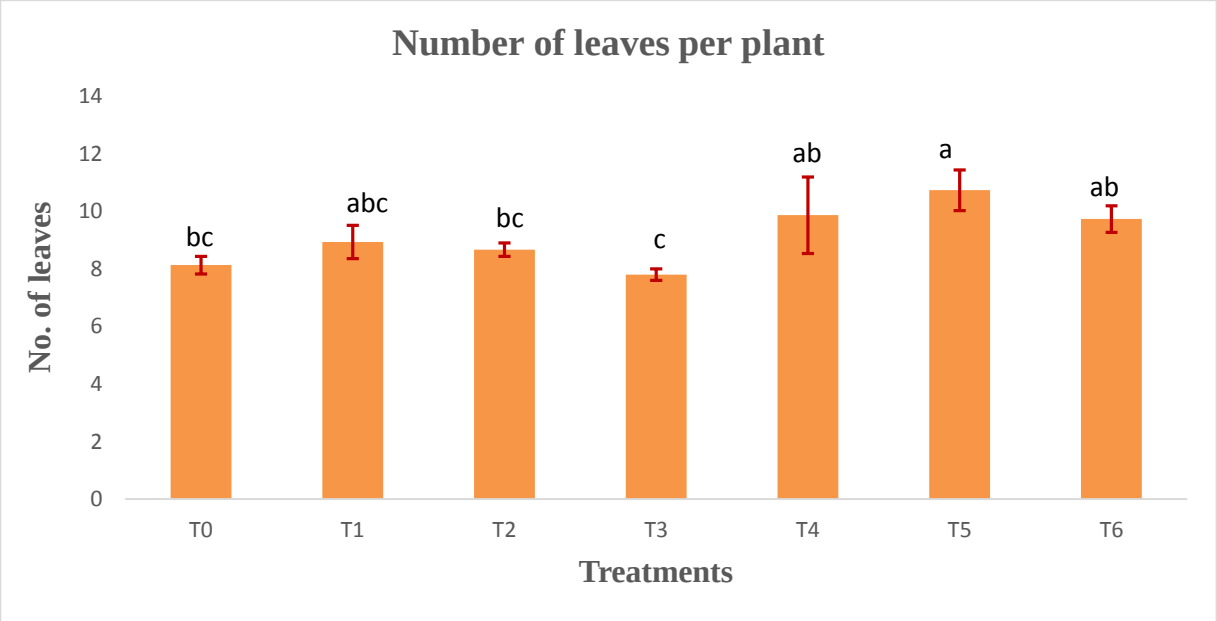

Figure 3: Effect of powdered and composted meat bone on leaves number of Water spinach

2. Root length per plant (cm)

Length of root per plant ranged from 8.81cm to 13.91cm and highest length of root found in T_6 (13.91cm) (Table 1). Length of root varied significantly in T_6 compared with control treatment T_0 and there was the insignificant difference among T_1, T_2, T_3, T_4 and T_5 (Figure 4). A distinct difference was found between T_0 and T_6. So, application of compost of pigeon bone showed a significant increment of length of root in water spinach whereas application of powdered chicken bone, beef bones did not show any positive effect on the root length of water spinach. On the basis of the length of the root of plants application of composted pigeon bone is the best for uses, and it can be recommended for the plants.

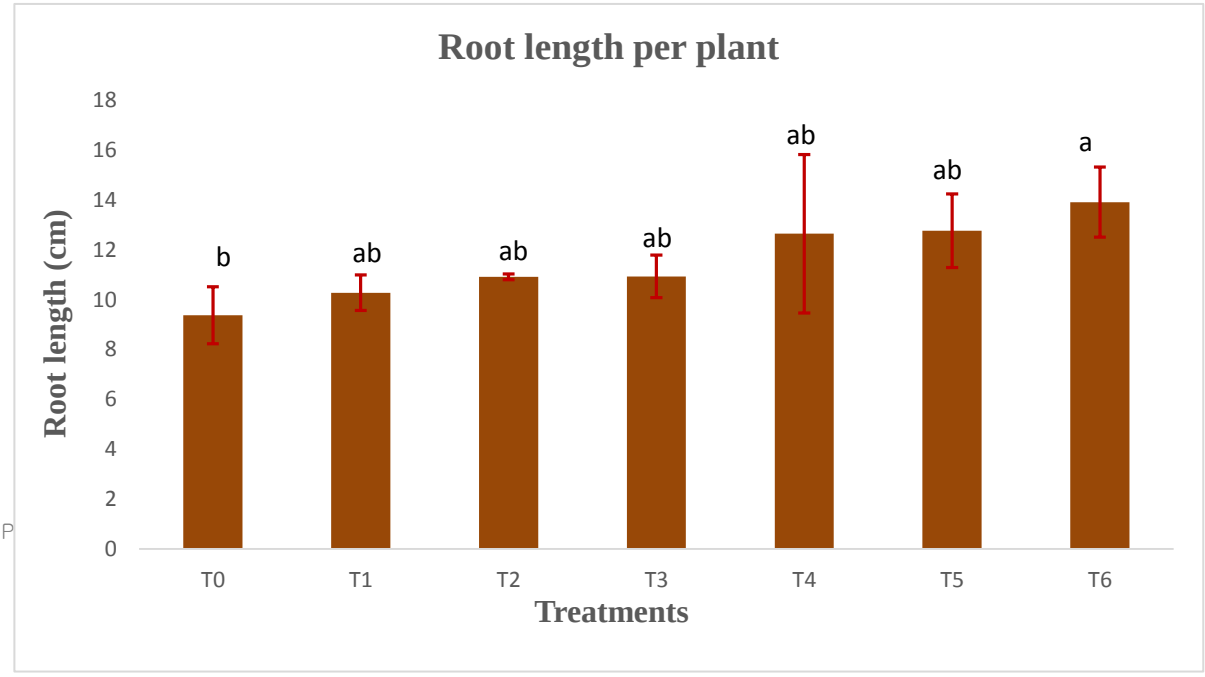

Figure 4: Effect of powdered and composted meat bone on root length of water spinach

3. Shoot length per plant (cm)

Length of shoot per plant ranged from 17.64 cm to 24.96 cm. and highest length of shoot was found in T_5 (24.96cm) (Table 1). There was insignificant relationship between T_1, T_2 and T_6 but significant difference was found in T_5 compared with the control treatment T_0 (Figure 5). So, application of composted chicken bone showed significant increment of length of shoot in water spinach whereas application of other meat bone fertilizers did not show any positive effect on the shoot length of water spinach. On the basis of the length of shoot of plants application of composted chicken bone is the best for uses and it is recommended for the plants.

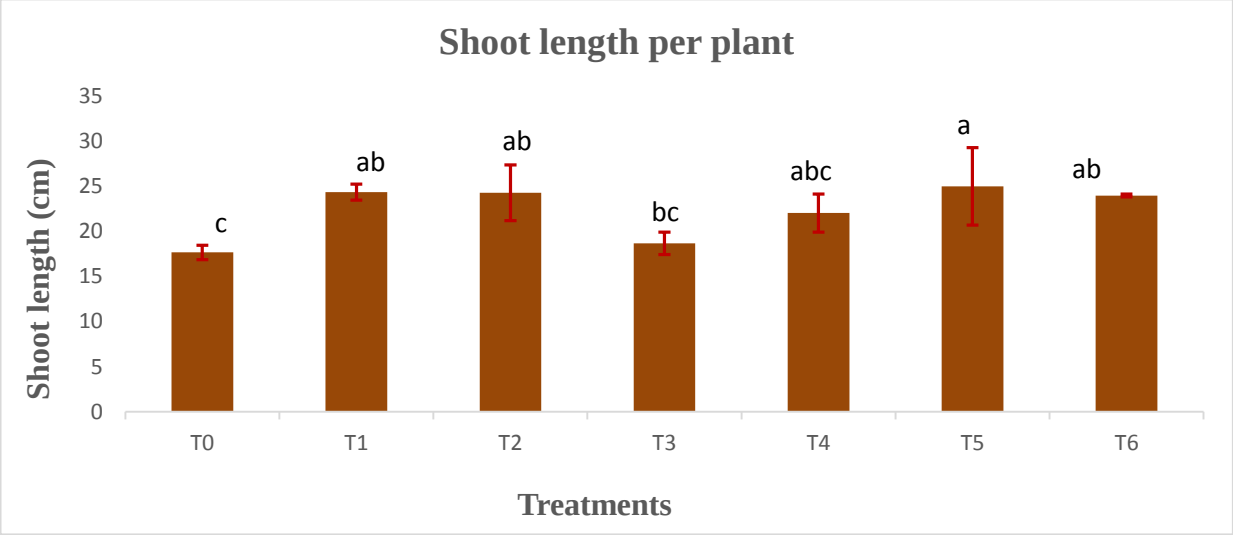

Figure 5: Effect of powdered and composted meat bone on shoot length of water spinach

4. Fresh weight per plant (g)

Fresh weight per plant ranged from 1.09g to 3.47g and highest fresh weight of plant was found in T_5 (3.47g) (Table 1). Fresh weight varied significantly in T_4, T_5, T_6 compared with control treatment T_0 but there was the insignificant difference between T_0, T_1, T_2 and T_3 (Figure 6) The observation was $T_5 > T_6 > T_4 > T_1 > T_2 > T_3 > T_0$. So, application of compost of chicken bones showed a significant increment of fresh weight in water spinach, whereas

application of meat bones and pigeon bones did not show any positive effect on the fresh weight. On the basis of the fresh weight of plants application of composted chicken bone is the best for uses, and it is recommended for the leafy vegetables.

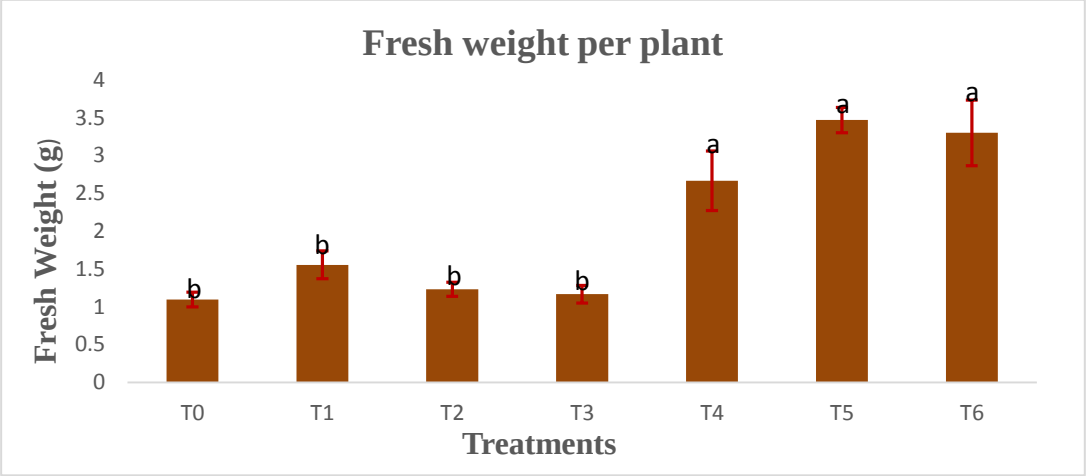

Figure 6: Effect of powdered and composted meat bone on the fresh weight of water spinach

5. Dry weight per plant (g)

Dry weight per plant ranged from 0.08g to 0.52g and highest dry weight was found in T_5 (0.52g) (Table 1). Dry weight varied significantly in all treatments compared to the control treatment T_0 and there was an insignificant difference between T_2 and T_3 as well as T_1 and T_4 (Figure 7). So, application of compost of chicken bone showed significant increment of the dry weight in water spinach whereas application of other meat bone fertilizers did not show any positive effect on the dry weight. On the basis of dry weight of plants application of composted chicken bone is the best for using and it is recommended for the plants.

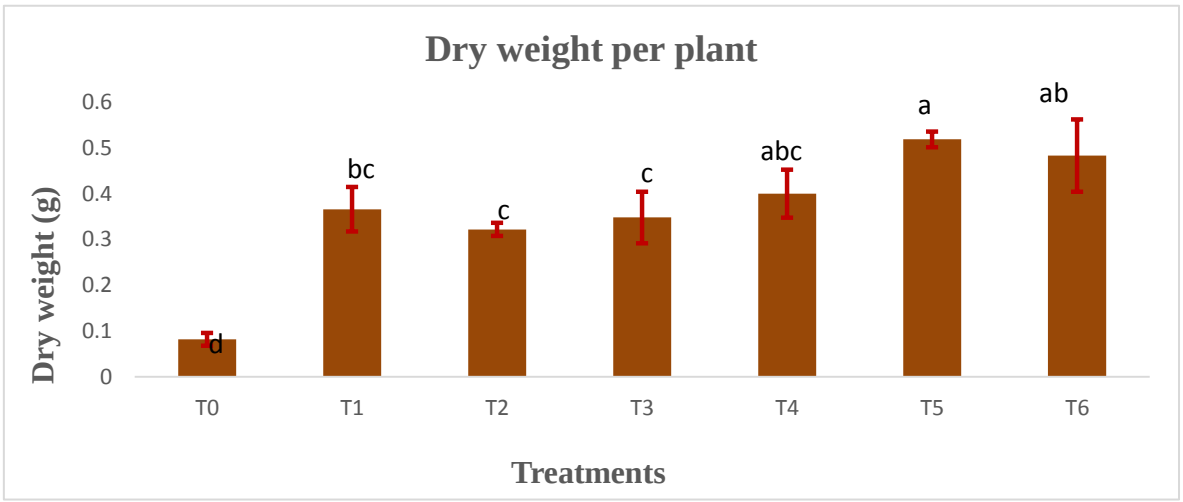

Figure 7: Effect of powdered and composted meat bone on the dry weight of water spinach

6. Moisture content per plant (%)

Moisture content per plant ranged from 64.36% to 85.39% and highest moisture content found in T_6 (85.39%) and the lowest moisture content observed in T_0 (Table 1). The observations are $T_6 > T_5 > T_4 > T_1 > T_2 > T_3 > T_0$. The following figure shows significant differences when control experiment is compared with other treatment and significant differences are found in T_1 and T_3 but insignificant relationship was found among T_4, T_5 and T_6 treatments (Figure 8). So, application of compost of pigeon bone showed a significant increment of moisture content of water spinach whereas application of chicken bone, beef bones both powdered and composted did not show any positive effect on the moisture content of water spinach. On the basis of the moisture content of plants application of composted pigeon bone is the best for using and it can be recommended for the plants.

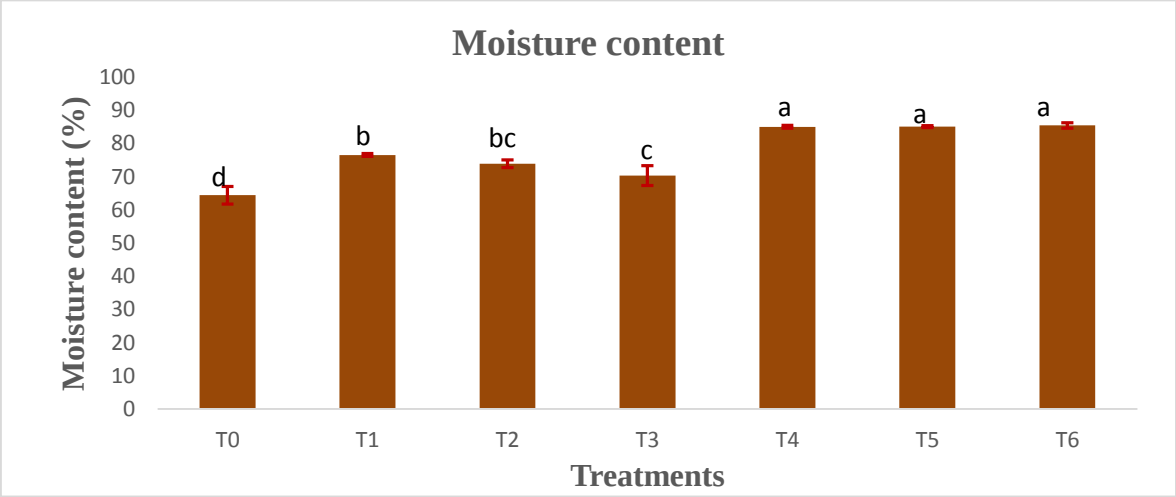

Figure 8: Effect of powdered and composted meat bone on the moisture content of water spinach

IV. SUMMARY AND CONCLUSION

Powdered and composted meat bones contain sufficient nutrients such as nitrogen, phosphorus, potassium, calcium which are capable to enhance the growth rate of plant. This research has revealed that meat bones both powdered and composted, has significantly increased the growth parameters of water spinach (*Ipomoea aquatica*) such as number of leaves, shoot length, fresh weight, dry weight and moisture content. The result showed that these parameters are mostly increased by using composted chicken bones compared to that of other treatments. Only root length and moisture content of water spinach is increased by using composted pigeon bones. The highest vegetative growth was found by using composted chicken bones, and lowest vegetative growth was found at control experiment. So, the use of composted chicken bone has the potential to show the highest response on the growth and yield of water spinach and other types of leafy vegetables.

So, it is recommended for the formers to use composted meat bones specially composted chicken bones for the improvement of soil quality and to improve its productivity. On the contrary, a load of waste from meat bones will be reduced and will help in waste management. In the same time, the use of costly and harmful chemical fertilizers will be

reduced and will introduce organic farming, which is environment friendly and beneficial for human health.

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