EFFECT OF HOUSEHOLD ORGANIC WASTE COMPOST ON GROWTH AND YIELD OF INDIAN SPINACH (*Basella alba* L.)

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BY

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CERTIFICATE

*This is to certify that thesis entitled, "**EFFECT OF HOUSEHOLD ORGANIC WASTE COMPOST ON GROWTH AND YIELD OF INDIAN SPINACH (Basella alba** **L.)**" submitted to the Faculty of Agriculture, Sher-e-Bangla Agricultural University, Dhaka, in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE** in **Agroforestry and Environmental Science**, embodies the result of a piece of bona-fide research work carried out by **MD. RASED MIA, Registration No. 14-06219** under my supervision and guidance. No part of the thesis has been submitted for any other degree or diploma.*

I further certify that such help or source of information, as has been availed of during the course has duly been acknowledged.

Dated: June, 2021
Place: Dhaka, Bangladesh

Abdul Halim
Assistant Professor
Supervisor

DEDICATED TO

MY BELOVED PARENTS

AND

MY NEPHEW

SAUBAN AHMAD

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-The Author

EFFECT OF HOUSEHOLD ORGANIC WASTE COMPOST ON GROWTH AND YIELD OF INDIAN SPINACH (*Basella alba* L.)

ABSTRACT

Household organic waste (HOW) can be managed in an environmentally feasible way by preparing compost and using them to produce organic vegetables for family consumption in kitchen yard or rooftop garden. So, a pot experiment was conducted in the field laboratory of the Department of Agroforestry and Environmental Science, Sher-e-Bangla Agricultural University, Dhaka 1207, from March 18 to May 17, 2020 to observe the effect of household organic waste compost on the growth and yield of Indian spinach (*Basella alba* L.) under five different treatments 1. T0: only the field soil ; 2. T1: 20% of HOW compost and soil; 3 T2: 40% of HOW compost and soil; 4. T3: 50% of HOW compost and soil; and 5. T4: Recommended dose of fertilizer in completely randomized design with three replications. The results showed significant positive influence of HOW compost which were increased plant height, leaf number, stem diameter, fresh and dry weight resulting in higher yield. Treatment T4 showed highest fresh weight and stem length which are expected attributes in commercial large scale cultivation. Among the three HOW compost treatments T3 showed highest fresh weight, dry weight, leaf number and stem length. So treatment T3 is preferable for organic cultivation in the homestead or in the rooftop garden.

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Elaborations	**Abbreviations**
Percentage	%
and others *(at elli)*	*et. al.,*
Agricultural	Agril.
Analysis of variance	ANOVA
Household organic waste	HOW
Least significant difference	LSD
Centimeter	cm
Percentage of Coefficient of Variation	CV%
Degrees of Freedom	df
Sher-e-Bangla Agricultural University	SAU
Gram	g
Kilogram	kg
Completely Randomized Design	CRD
Non-significant	NS
Parts per Million	ppm
Agro Ecological Zone	AEZ

CHAPTER 1

INTRODUCTION

Household organic waste (HOW) is a highly decomposable matter which can cause environmental pollution if doesn't managed properly. For this reason it is very crucial to manage the household organic waste and it will be the best choice if we use the HOW to make compost and then use it to grow organic vegetables in the kitchen yard or in the rooftop as rooftop gardening is very popular now-a-days. It will simultaneously help to reduce environmental pollution and to grow organic vegetables. In city areas, it is difficult to manage the growing media for rooftop gardening. If we can decompose the HOW properly in an environment friendly way it will serve as both the growing media and organic fertilizer. Composts when applied to the soil help to improve the physical and chemical properties of soil by adding organic matter and nutrients. Organic matter, including organic wastes from agricultural activities, plays an important role in improving soil fertility, through its role as a granulator and nutrient source (Kusnarta *et. al.,* 2021)

Growth and yield of a crop depends solely on the nutrient availability in the growing media. Nutrients can be supplied to the plants by applying inorganic fertilizers or applying composts. HOW compost can be a better source of nutrients because it is made by decomposing kitchen wastes which are consists of different types of organic matter. Home composts may be helpful to improve organic matter content and nutrient availability in infertile tropical soils (Faverial and Sierra, 2014).

Environmental pollution is a matter of great concern at present times. Household waste management can reduce the pollution to a great extent and provide composts for crop production. Home composting helps individuals and families to reduce the amount of household waste at the same time gaining a fertilizer material (compost) of excellent quality for gardens or vegetable plots (Vazquez and Soto, 2017)

In big cities and towns rooftop gardening has become a popular practice. Innovative forms of green urban architecture aim to combine food, production, and design to produce food on a larger scale in and on buildings in urban areas. It includes rooftop gardens, rooftop greenhouses, indoor farms, and other building-related forms (Spetch *et. al.*, 2014). In this regard HOW compost can be the best solution to growing media and manure collection.

Indian spinach is one of the most popular, delicious and nutritious leafy vegetables. "Indian spinach is a nutrient rich leafy vegetable grown in the summer season in Bangladesh. It is a fleshy annual, twining much branched herb with alternate ovate leaves. There are two varieties, green and red. The nutritive value of Indian spinach is very high with a good content of minerals, vitamins and substantial amount of fibers" (Ghosh and Guha, 1993). The forms of Basella spp. contained phytochemicals and antioxidant properties in varied amount. The *Basella alba* has the potential of use as natural antioxidants need by humans. *Basella alba*, round leaf, had the highest contents of phenol (0.22 ± 0.02%) and vitamins A and C, 21.96 ± 0.01% and 21.67 ± 0.90%, respectively (Adenegan-Alakinde and Ojo, 2019).

Organic vegetables are getting preference day by day its health benefits all over the world. The success of organic agriculture can be attributed to a number of causes. First, organic farmers do not depend on artificial fertilizer and pesticide inputs, which can be expensive. In addition, organic foods currently enjoy a price premium over usually produced foods, meaning that organic farmers can often get more for their yield. Compared to orthodox agriculture, the energy efficacy of organic farming is influenced by crop type and farmstead size. It has generally been found that the labor input per unit of yield was higher for organic systems compared with conventional production. For this organic farming is not suitable for large scale cultivation. Moreover the input needed for organic farming are also costly. "Based on existing consumer science literature, organic foods are mainly perceived as healthier and safer compared to conventional foods. From a scientific point of view however, there is currently not enough evidence to unconditionally recommend organic foods over conventionally produced foods” (Williamson, 2007; Hoefkens *et. al.*, 2008).

Considering the facts mentioned above, the present research has been undertaken with the following objectives:

- To compare the growth and yield performance of household organic waste compost with recommended dose of fertilizer
- To find out the effective dose of household organic waste compost and to grow organic vegetables

CHAPTER 2

REVIEW OF LITERATURE

Indian spinach is a popular vegetable in Bangladesh and many other countries around the world. It is cultivated and consumed in many ways. Cultivation of vegetables using organic composts to grow organic vegetables has become very popular today. Here in this experiment Indian spinach cultivation with household organic waste compost will be stated and growth and yield performance will be evaluated.

Some of the research findings relevant to the growth and yield of Indian spinach as influenced by different doses of household organic waste compost have been reviewed here-

2.1 Nutrient value of Indian spinach

Haskell *et. al.,* (2004) reported that daily intake of *B. alba* has a positive outcome on total-body vitamin A stores in men.

Kumar *et. al.,* (2015) reported that "the water rich leaves have a mild aroma and somewhat mucilaginous making it a good substitute to water leaf. It is reported to be low in calories and fat but very high in vitamins, minerals and antioxidant. It has been defined as functional food that lower the risk of various diseases. It is widely used in traditional medicine to treat ulcer, fever, hormonal imbalance, constipation, inflammation, wound and neutralize poison also".

"*Basella* species are endowed with various industrially important chemicals such as acacetin, anthraquinone, basellasaponins A, B, C and D, betacyanin, ferulic acid. It's anti-inflammatory and anti-bacteria properties" was also reported (Azad *et. al.*, 2013).

Anonymous (1988) reported that "*Basella alba* is testified to have several phyto-elements such as proteins, alkaloids, carbohydrates, polysaccharides, phenols, flavonoids, carotenoids, minerals and vitamins".

Adhikari et. al., (2012) reported that "The ethanobotanical properties of *Basella alba* have been reviewed in this article. Various parts of the plant are used for treatment of the diseases as well as for different healing activities of human beings as well as animals across the globe especially in India and China. Its use has been discovered as asperient, rubefacient and for catarrhl infections. Some of the compounds available especially in the plant are basellasaponins, kaempherol, betalin, etc. Several extracts like aqueous, chloroform, ethanol and petroleum has been used for different pharmaceutical activities".

Daniyan *et. al.,* (2008) reported that *"Basella alba* is also an essential ethno veterinary remedial plant used for the treatment of retained after birth and anaplasmosis and administered in balanitis and gonorrhoea. The mucilaginous liquid acquired from the leaves and tender stalks of this plant is a remedy for habitual headaches. A decoction of the leaves is a good laxative for pregnant women and children".

Bamidele *et. al.,* (2010) found that "*B. alba* has immense potential activity on diabetes and this has been scientifically well established. The aqueous abstract of *B. alba* leaf exhibited anti-diabetic consequence on alloxan induced diabetic rats". "The mucilage present in *B. alba* has been credited with hypoglycaemic activity" (Palanuvej *et. al.,* 2009). "It also possess CNS depressant activity, gastro protective activity", (Anandarajagopal *et. al.,* 2011) "anti-inflammatory activity", (Krishna, 2012). "Membrane stabilization property in human blood cell membrane", (Kumar *et. al.,* 2011) "antibacterial activity". (Mohammed *et. al.,* 2012) "wound curing and anti-ulcer activity" (Acharya *et. al.,* 2012). *"B. alba* is consumed in food preparations in southern India. In Ayurveda the drug is used for various indications either alone or in combination for mada (intoxication), anidraā (insomnia), paādadari (cracked feet), jvara (fever), pravaāhikaā (dysentery), arśhas (haemorrhoids), śiātapitta (urticaria), vranaśotha (inflammatory), arbuda (tumours), raktapitta (bleeding disorders). The plant is used in Ayurveda treatment for cancer management" (Acharya, (2011). "Pharmacognostic profile of the *B. alba* hasn't yet been carried out and hence the present work focuses on its pharmacognostic profile" (Adhikari *et. al.,* 2012).

Annonymous, (2013) reported that "Indian spinach is a very versatile leaf green vegetable and it contains an incredibly good amount of vitamins, minerals, and antioxidants. Indian spinach leaves and stem are incredibly rich sources of vitamin A and vitamin C. This green leafy vegetable also contains good amounts of many B-complex vitamins such as folate, vitamin-B6 (pyridoxine), and riboflavin. *Basella alba* leaves are very rich sources of minerals like potassium, manganese, calcium, magnesium, and copper. Indian spinach is an excellent source of iron, an important trace element, required by the human body for red blood cell (RBC's) production. Fresh leaves of Indian spinach are rich sources of several vital carotenoid pigment anti-oxidants such as ß-carotene, lutein, zea-xanthin. These compounds play a healing role in aging and various disease processes".

Adhikari, (2012) "Indian spinach has been used from a long time back for the treatment of many diseases like dysentery, diarrhea, anemia, cancer etc".

Zewail *et. al.,* (2020) reported that "cancer is a class of diseases characterized by uncontrolled cell growth. The current treatment options of cancer are radiotherapy, chemotherapy, hormone therapy, and surgery, where all of them have unpleasant side effects. Due to their adverse side effects, it is challenging to develop new drug for cancer treatment. Hence, the scientists are trying to search for noble complexes from natural bases to treat cancer. Therefore, in the present investigation, a widely consumable vegetable *Basella alba* was subjected to evaluate its anti-proliferative outcome along with molecular signaling of apoptosis in Ehrlich ascites carcinoma (EAC) cell line".

Mie *et. al.*, (2017) found that "the use of organic methods in agriculture is of great significance in producing healthy, nutrient-rich, and safe foods".

Kananke *et. al.*, (2014); and Nadeeshani, (2018) viewed that "growing of leafy vegetables in homestead gardens are comparatively easy and much popular as they grow faster within a shorter period. The interest in cultivation and the consumption of leafy vegetables i.e., *Centella asiatica*, *Alternanthera sessilis*, ***Basella alba***, *Amaranthus viridis*, *Trianthema portulacastrum* etc. are also high among Sri Lankans due to the presence of high nutrients i.e., calcium, iron, phosphorus and micro-nutrients, fibers, vitamin A, C and K, carotenoids, folate and a wide range of antioxidants and flavonoids".

2.2 Benefits of using Household Organic Waste Compost

Haynes *et. al.*, (1998) reported that "the addition of organic materials provides many beneficial effects on soil physical properties i.e. increasing water infiltration capacity, water holding capacity, aeration, porosity and permeability, water- 394 stable soil aggregation and rooting depth while decreasing soil crusting, bulk density, runoff and erosion".

Clement, (2005) reported that "organic manure contributes to fertility of the soil by adding organic matter and nutrients such as Nitrogen etc. Organic matter is a by-product obtained from decomposed cow dung, chicken litters (poultry manure), goat manure and decay of dead leaves which increases the soil with essential element and humus to the soil. There are three (3) main classes of organic manure used by the soil plant manure, animal manure, compost manure. The animal manure contains the faeces of animals which have different quantities and requires different application rate when used as manure".

Jedidi *et. al.*, (2004) stated that "for sustainable agricultural production use of efficient manure to maintain the soil and plant quality is important. The application of organic manure has been practiced for more than thousand years in many countries since it provides essential nutrients to plants, improves soil structure, helps in the moisture and to absorb the nutrients in the soil”.

Zakaria and Vimala, (2002) and Sunassee, (2001) observed that “increase in yields of vegetables crops with application of poultry of manure. The increase in soil nutrients by application of organic manure than the unmanured soil shows the ability of organic manures to improve soil chemical properties. Also, the possible adjustment in soil pH through the application of organic manures compared to the control shows their liming effect”.

Sanni, (2016) reported that “Animal manure is known to be effective in maintenance of adequate supply of organic matter in soil, with improvement in soil physical and chemical condition and enhanced crop performance, poultry, cattle, sheep and pig manure has been found to improve soil fertility and crop yield. Poultry and cattle manure to soil lead to increase in soil PH, Organic Carbon, Nitrogen, Phosphorus, Calcium, Potassium, Magnesium, Sodium and CEC. Therefore the aim of this study is to assess the effect of cow dung, compost and inorganic fertilizer (NPK) on the growth and yield of amaranth and on chemical properties of the soil.”

Mee and Topping, (1998) found that “household wastes are the organic and inorganic wastes generated by rapid increased production, consumption and other human and animal activities of the urban society, normally discarded as useless or unwanted or those which have lost their value to the first user and are a major cause of pollution. Compost is a mixture of dissimilar ingredients used to enrich and improve the soil. It is commonly prepared by decomposing plant and food waste and recycling organic based materials. The resulting mixture is rich in plant nutrients and beneficial organisms, such as worms and fungal mycelium. Compost improves soil fertility in gardens, landscaping, horticulture, urban agriculture, and organic farming. The benefits of compost include providing nutrients to crops as fertilizer, acting as a soil conditioner, increasing the humus or humic acid contents of the soil, and introducing beneficial colonies of microbes that help to suppress pathogens in the soil. It also reduces expenses on commercial chemical fertilizers for recreational gardeners and commercial farmers alike".

Annonymous, (2013) observed that "in developing countries, increasing waste production accompanies to urbanization" (Ahmed and Ali 2004) and "the waste produced generally has high moisture content and a low combustible fraction (e.g., paper and cardboard)" (Ali. 2003) and "originate to be composed of vegetative stock (44%) and inert materials (42%) in a developing country like India" (Damodaran *et. al.*, 2003). "Metropolitan population progression and economic growth not only accelerate consumption rates but also increase the waste generation in developing countries" (Alamgir and ahsan, 2007).

Ranasinghe *et. al.*, (2021) reported that "the agricultural production is highly affected by climate and weather changes i.e., climate extremes and constraints due to unpredicted rains and other natural perils which will remarkably reduce agricultural production".

Pradhan *et. al.*, (2015) reported that "climate change has led the government to increase the focus of the public in maintaining their home gardens, which are under the control against natural disasters as well as undue effects of chemical fertilizers. Hence, there will be a higher possibility for most people to start their cultivations in their home gardens. Especially during the COVID-19 incidence in 2020, most Sri Lankans tried to cultivate their home gardens". "Furthermore, the prevalence of chronic kidney disease in the major parts of the country discourage farmers to use synthetic agrochemicals in agriculture".

Weeraratna, (2013) stated that "As a remedial measure to the above problems, home gardens or commercial agriculture needs to introduce cost-effective and environmentally friendly fertilizers".

Mie *et. al.,* (2017) reported that "the use of organic methods in agriculture is of great significance in producing healthy, nutrient-rich, and safe foods".

Shormin and Kibria, (2018) reported that "household waste like fish waste is another potential organic waste to enhance the nitrogen content as the growth of leafy vegetables preferentially required a higher nitrogen content for their vegetative growth".

Yakui, (2009) reported that "Environmental-friendly organic manures diminish the adverse effects of chemical fertilizers. This study was lead to articulate organic liquid fertilizers using selected plant materials i.e., *Tithonia diversifolia*, *Mikania scandens*, *Chromolaena odorata* and *Gliricidia sepium* with selected organic wastes to relate the efficacies of foliar and soil-applications over the progress of leafy vegetables; *Basella alba* and *Centella asiatica*. Research Method: Selected plant materials were allowed to decompose for two months and thereafter fish waste was hydrolyzed separately with fruit wastes of *Carica papaya*, *Ananas comosus* and (1:1 w/w) mixture of both were mixed and nutrients analyzed. Fertilizers were foliar and soil-applied separately on *C. asiatica* and *B. alba* in CRD in pot trials. Results: Fertilizer formulated with decomposed plants + fish waste hydrolyzed with C. papaya significantly recorded the highest N (0.57%), P (0.06%) and highest growth of *C. asiatica* and *B. alba* over both soil and foliar applications followed by the fertilizer formulated with decomposed plants + fish waste hydrolyzed with C. papaya + A. comosus. Foliar-application of *B. alba* significantly showed the highest growth than the soil-application [shoot height (36.6±3.4 cm vs 30.0±1.5 cm), number of leaves per plant (21.7±1.4 vs 17.5±0.8) and plant fresh-weight (61.5±1.8 vs 55.6±0.9 g)] whereas, *C. asiatica* indicated no significant difference considering both fertilizer solicitation methods. Research constraint: Pot experiments were carried out to offer uniform soil circumstances for the experiment which was the main limitation compared to field trials. Originality/value: The expressed novel fertilizers could be utilized effectively in organic farming for safe and healthy leafy vegetables which reduce the adverse impacts of chemical fertilizers".

Burnett *et. al.,* (2016); Wakui, (2009) stated that "organic fertilizers are derived from plant-based raw materials i.e., crop residues, green manures, wood ash, fruit waste, domestic waste, woodland litter, seagrass, etc. and/ or animal-based materials such as livestock manure, bird dropping, fish waste and bone meals, etc".

Grubben and Denton (2004) observed that "*Basella alba* thrives well in soils that are rich in organic manure".

Islam *et. al.,* (2011) observed that "The outcome of organic manure and chemical fertilizers on vegetable crops and soil properties in the radish-stem amaranth-Indian spinach cropping pattern was studied in a homestead area of Gazipur district in Bangladesh. There were eight treatments - poultry manure (PM) 5 t ha-1 (T1), cowdung (CD) 10 t ha-1 (T2), household waste (HW) 10 t ha-1 (T3), PM 2.5 t ha-1 + reduced RDF (recommended dose of fertilizer) (T4), CD 5 t ha-1 + reduced RDF (T5), HW 5 t ha-1 + reduced RDF (T6), 100% RDF (T7) and Control (T8). The 100% RDF treatment (T7) gave the highest radish yield, however identical yield was obtained with T5 and T6 treatments. The extreme yield of stem amaranth and Indian spinach was attained with T4 and T6 treatments, respectively. The highest N, P, K and S uptake was found in T7 for radish, T4 for stem amaranth and T6 for Indian spinach. Soil bulk density and organic carbon were improved due to application of organic manure. The highest nutrient availability was recorded with T4 treatment that was followed by T6. Among the treatments, the poultry manure 2.5 t ha-1 + reduced dose of recommended fertilizer and house hold waste 5 t ha-1 + reduced dose of recommended fertilizer were found suitable for achieving sustainable vegetable crop yield as well as for sustaining of soil health at homestead area."

Ranasinghe *et. al.,* (2021) found that "organic fertilizers showed significantly higher growth performances compared to the untreated negative control showing their potential to utilize as organic fertilizers in cultivating safe and healthy leafy vegetables at home gardens reducing the adverse impacts of chemical fertilizers. Therefore, it is recommended that correctly formulated organic liquid fertilizers provide higher yields and a sustainable soil health".

Alam *et. al.,* (2007) reported that "in today's era, heavy doses of chemical fertilizers and pesticides are being used by the farmers to get a better yield of various field crops. These chemical fertilizers and pesticides decreased soil fertility and caused health problems to the consumers. Due to adverse effects of chemical fertilizers, interest has been stimulated for the use of organic manures".

2.3 Effect of HOW compost on growth and yield

Pascual *et. al.,* (1997); Michael and Allen, (1998) stated that "the use of organic matter such as animal manures, human waste, food wastes, yard wastes, sewage sludges and composts has long been recognized in agriculture as beneficial for plant growth and yield and the maintenance of soil fertility. The new approaches to the use of organic amendments in farming have proven to be effective means of improving soil structure, enhancing soil fertility and increasing crop yields".

Makinde *et. al.,* (2011) observed that "adequate supply of N, P, and K, by the application of the different sources of organic manures at 10 t/ha might have led to increase amount of Total Organic Carbon, Total Nitrogen and Potassium in the composted soil and hence increase the growth of *Basella alba* grown in this medium".

Johnston *et. al.,* (1995) stated that "organic matter are excellent source of plant-available nutrients and their addition to soil could maintain high microbial populations and activities. The important roles of organic waste compost in the soil and their potentially positive effect on crop yields have made organic amendments a valuable component of farm fertilization and management programs in alternative agriculture. Forms of organic matter used include crop residues as mulches, among others".

Chaoui *et. al.,* (2002) found that "the applications of HOW compost to the soils may have added to the aboriginal soil microorganism populations, activity and diversity, resulting in much larger, richer and diverse soil microbial populations. Some microorganisms can form synergistic relationships in plant rhizospheres, by acting as root extensions, thereby increasing the capacity of plants to utilize soil moisture and nutrients, and at the same time they benefit from plant root exudates. Other byproducts of microbial activities known to promote plant growth".

Padmavathiamma *et. al.,* (2008) showed that "the reuse of wastes for agricultural puropse to improve soil properties and increase crop yield is a good solution for minimizing these problems. Nowadays, with the increasing demand to preserve natural assets and energy, recycling of wastes accepts major importance".

Quintern *et. al.,* (2006) reported that "in organic agriculture, the use of organic fertilizers such as manure and compost have been important components of farming practices Sanni *et. al.,* (2016) observed that the growth and yield of *B. alba* positively to the amendment of the soil with the addition of NPK 15-15-15, compost and cow dung compared to control".

Mona *et. al.,* (2008) reported that "the height of plant the most important growth parameter increases to a great extent by applying organic compost".

Iktidar *et. al.,* (2006) reported that "plant height is an important component that helps to determine plant growth. The increase in height of *B. alba* plants amended with organic and inorganic fertilizers is probably due to release of nutrients which promoted vigorous plant growth through efficient photosynthesis".

Carrera *et. al.,* (2007) stated that "soil application of organic fertilizers as classic solid compost, fresh or digested organic materials (are the most common method of supplying essential nutrients to plants that are facilitating the absorption of applied nutrients by the roots. Application of organic matter in the soil increases nutrient availability of soil".

Scheu, (1987) reported that "household organic compost produces a natural fertilizer and improves the physical, chemical as well as biological properties of the soil. These composts provide all nutrients in readily available forms and also enhances uptake of nutrients by plants and plays a major role in improving growth and yield of different field crops".

Narkhede *et. al.,* (2011) reported that "the growth determining characters like height, fresh weight, dry weight, leaf number etc. are increased by the application of HOW compost in different leafy vegetables including *Basella alba".*

Ghosh *et. al.,* (2017) observed that "the experiment that Indian spinach treated with organic manure significantly performed better than the uncomposted soil in all the growth parameters assessed. There is an improvement in the growth of the plant which eventually influence the productivity of Indian spinach because the higher the number of leaves the higher the rate of photosynthesis in the plant hence the higher the yield".

Oyedeji *et. al.,* (2014) reported that "the animal manures increased stem girth of vegetables compared to inorganic fertilizers. The significantly higher stem girth observed in the application of organic manures".

CHAPTER 3

MATERIALS AND METHODS

This chapter illustrates the related methodology used in completing of the experiment to study the effect of household organic waste compost on growth and yield of indian spinach (Basella alba). This part comprises a brief explanation of location of experimental site, climate and soil, planting materials, layout and design of the experiment, pot preparation, fertilizing, intercultural operations, harvesting, data collecting methods, statistical analysis etc. which are presented as follows:

3.1 Experimental site

This experiment was executed in the Field laboratory of Agroforestry and Environmental Science Department, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh during the period from March 27 to May 17, 2020. Location of the site is 23°74'N latitude and 90°35'E longitude with an elevation of 8 meter from sea level (Islam, 2014; Laylin, 2014) in Agro-ecological zone of "Modhupur Tract" (AEZ-28) (Anonymous, 1988). The experimental site is stated in the map of AEZ of Bangladesh in [Appendix 1].

3.2 Climate and soil

Experimental site was located in the subtropical climatic zone, having with plenty of sunshine and moderately high temperature prevails during March 18 to May 17, 2020 (kharip-1 season), which is suitable for the cultivation of Indian Spinach in Bangladesh. Weather information and physiochemical attributes of the soil used in pot experiment are given in [Appendix 2 and Appendix 3, respectively].

3.3 HOW compost preparation

Organic wastes from the household mainly the kitchen wastes were collected from different dustbin of stuff quarters of sher-e-Bangla Agricultural University. The wastes were kept in some large plastic containers to be decomposed. The decomposition process was inspected timely. After well decomposition of the organic matter the compost was mixed thoroughly and made less coarse in texture.

3.4 Planting materials

In the experiment a high yielding variety of Indian Spinach called “Green Leaf” was used

3.5 Treatments of the experiment

The experiment was conducted to evaluate the performance of one Indian Spinach variety under 5 different treatments. These treatments were

(1) T0: only the field soil

(2) T1: 20% parts HOW compost and soil in pot

(3) T2: 40% parts HOW compost and soil in pot

(4) T3: 50% HOW compost and soil in pot, and

(5) T4: Recommended dose of fertilizer (according to the recommended dose of BARI for vegetable production).

3.6 Pot preparation

The experimental pot size was 36 cm in height, 32 cm in top diameter and 22 cm in bottom diameter. Pots were filled with HOW compost mixed soils for seed sowing and plant growth on March 18, 2020. Before soil filling, weeds, stubbles, stones and brick pieces were completely excluded from soil to ensure uninterrupted growth of plan roots and easy intercultural operations. The soil was dried for few days to destroy the soil borne pathogens. Pots of T1, T2 and T3 treatments filled with definite organic compost and soil, pots of T0 treatment filled with only field soil and pots of T4 treatment filled with recommended dose of fertilizer. For T4 treatment cow-dung, TSP, MOP and 1/3rd of urea were applied during pot preparation.

3.7 Design and layout of the experiment

The experiment was laid out and evaluated during Kharip-1 season 2020 in completely randomized design (CRD) using one factor which comprises of 5 treatments. The experiment was conducted in 3 replications and total 15 plastic pots were used.

3.8 Seed sowing and raising of seedlings

Seed sowing was carried out on March 27, 2020 in the treatment pots. Seedlings were raised in the pots using regular nursery practices. Recommended cultural practices were carried out before and after sowing seeds. When the seedlings become 15 days old on only two seedlings were allowed to grow per pot while additional seedlings were uprooted.

3.9 Intercultural operations

Recommended watering and intercultural operations were done when required for different treatments. Weeding was performed in all pots at regular interval to keep plants free of weeds. The seeds were soaked into water one night before sowing in the pot.

3.10 Irrigation and drainage

Irrigation was done regularly when no rain occurs. Irrigation is one of the most important prerequisites for proper growth of plants and it is more important when it is a vegetable crop. When heavy shower of rain occurs the standing water was removed from the pot to protect the plants from stem rot.

3.11 Fertilization

Split doses of urea were applied only for the treatment T4 (recommended dose). At 17 DAS 1^{st} split was given and at 30 DAS 2^{nd} split was given.

3.12 Harvesting and processing

Harvesting was done at the edible stage of Indian Spinach (at the age of 45 days from germination. Harvesting was done in 17th may 2020.

3.13 Data recording

Data were recorded from each pot based on growth and yield parameters. The data were recorded in two different growth stages. First time at the age of 25 days from germination of seeds and finally at harvesting at the age of 45 days from the germination of seeds. Data were recorded in respect of the following attributes:

3.14 Stem Length

Plant height of each plant was measured in cm unit at the age of 25 after seed germination and finally at the time of harvesting and the mean was calculated.

3.15 Stem Diameter

Stem diameter of each plant was measured cm unit by taking the circumference and the divided by the pie value. Stem diameter was measured two times. Firstly at 25 DAS and then finally at 45 DAS at the time of harvesting.

3.16 Leaf number

In case of leafy vegetables crop the number of leaf per plant is very important. The number of leaf was counted two times in the growing period. Firstly at 25 DAS and finally at 45 DAS at the time of harvesting.

3.17 Number of Branches per Plant

Branch number of each plant at mature stage was counted and mean was calculated.

3.18 Yield per plant

In case of Indian spinach the total stem with leaves i.e., fresh weight in gram per plant is considered as yield. At the time of harvesting the plants were uprooted and weighed in gram unit and the mean wear calculated.

3.19 Dry weight per plant

After harvesting and data collection the plants were dried in the sun and then oven dried. After oven drying the dry weight was measured in gram unit as dry weight per plant.

3.20 Statistical analysis

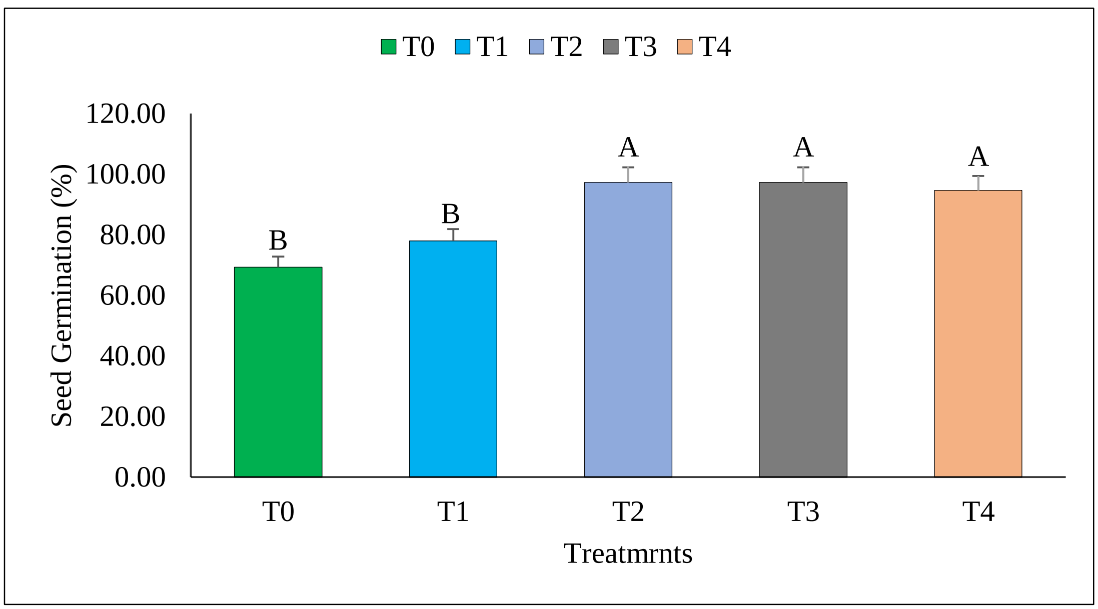
Collected data were tested statistically by using the Statitix 10 software. Mean for each treatments were calculated and analysis of variance and difference between treatments were assessed by Least Significant Difference (LSD) test at 5% level of significance (Gomez and Gomez, 1984)

CHAPTER 4

RESULT AND DISCUSSION

4.1 Seed germination percentage (%)

Seed germination percentage of *Basella alba* differ significantly by the application of different doses of HOW compost compared to treatment T0. Treatment T2 (97.33) and treatment T3 (97.33) showed the highest seed germination. Treatment T4 (94.67) showed only 3% lower than T2 and T3 (Figure 1). This difference may be due to the chemical composition of HOW compost which helps in better seed germination. Treatment T2, T3 and T4 are statistically similar in performance i.e there is no significant difference among them. Treatment T1 and T0 are also statistically similar.



*Column with the same letter are not significantly different at 5% level of significance

Figure 1: Seed germination (%) of different treatments

(Here, T0= control; T1= 20% HOW compost + soil; T2= 40% How compost + soil; T3= 50% How compost + soil; T4= Recommended dose)

Seed germination percentage of treatment T3 (97.33) was highest. T3 (94.67) was 3.33% more than T4 and 28% more than treatment T0 (69.33) (Figure 2).

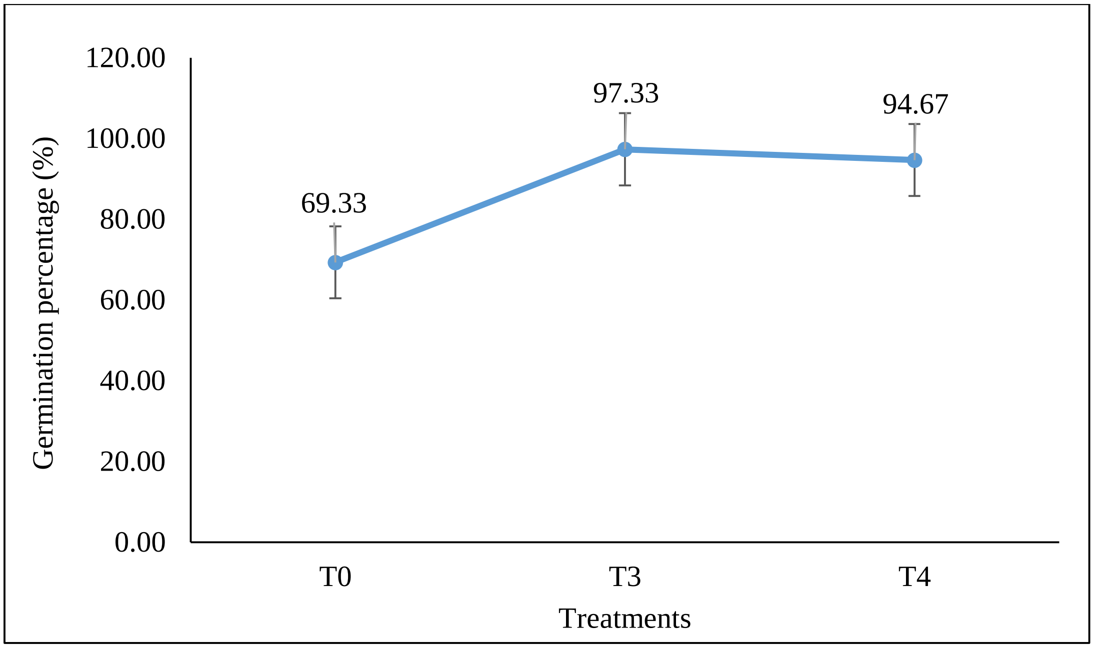
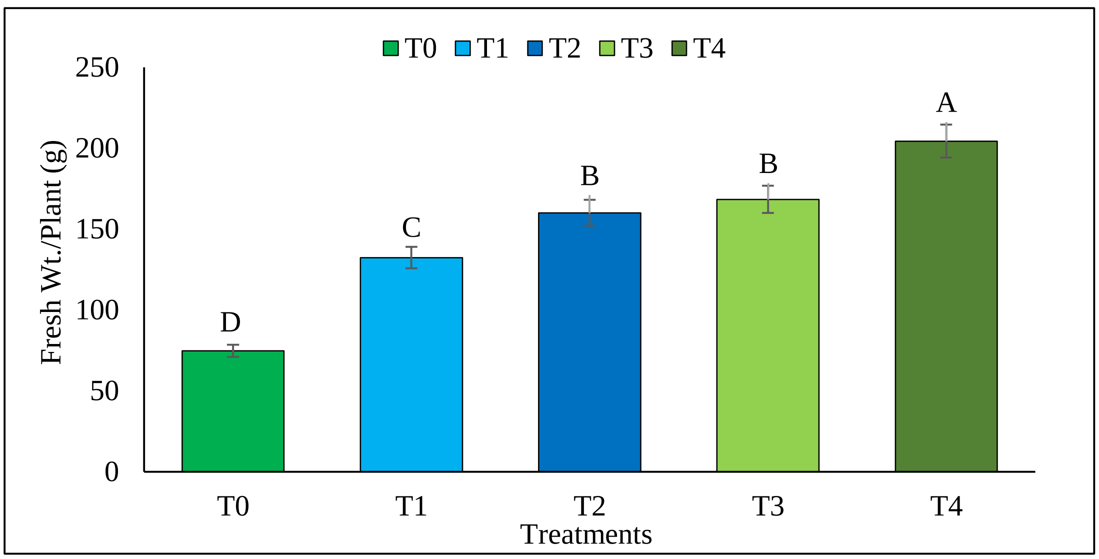


Figure 2: Comparison of seed Germination (%) of T0, T3 and T4 treatments

(Here, T0= control; T1= 20% HOW compost + soil; T2= 40% How compost + soil; T3= 50% How compost + soil; T4= Recommended dose of fertilizer)

4.2 Fresh Weight Plant^{-1}

Plant fresh weight of *Basella alba* differ significantly by the application of different doses of HOW compost compared to T0 (Figure 2). Treatment T4 gained the highest fresh weight per plant whereas T0 treatment had the lowest fresh weight per plant. Treatment T3 (160 g) and T2 (168 g) showed the close response to the organic fertilizer doses (T3>T2). T3 treatment gained 5% more fresh weight than T2 treatment. And the T4 treatment gained 18% more fresh weight per plant than the T3 organic treatment. The order of increment of fresh weight of different treatment was T0<T1<T2<T3<T4. Neither organic system of cultivation nor the inorganic system of cultivation can obtain the highest fresh weight of plant. Here the organic and inorganic combined treatment gained the highest fresh weight which is similar to the result of Islam *et. al.,* (2011).



*Column with the same letter are not significantly different at 5% level of significance

Figure 3: Effect of different treatments on fresh weight of plant

(Here, T0= control; T1= 20% HOW compost + soil; T2= 40% How compost + soil; T3= 50% How compost + soil; T4= Recommended dose of fertilizer)

At harvesting fresh weight per plant was highest in treatment T4 (204 g) which was 18% more than the treatment T3 (168g) and lowest result obtained in treatment T0 (75g) (Figure 4).

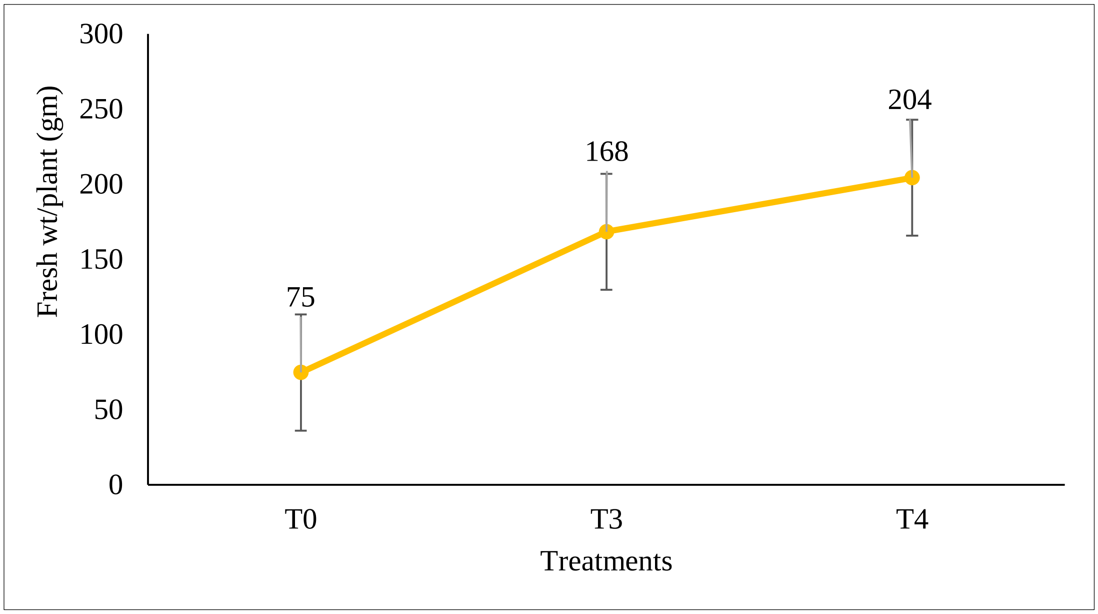
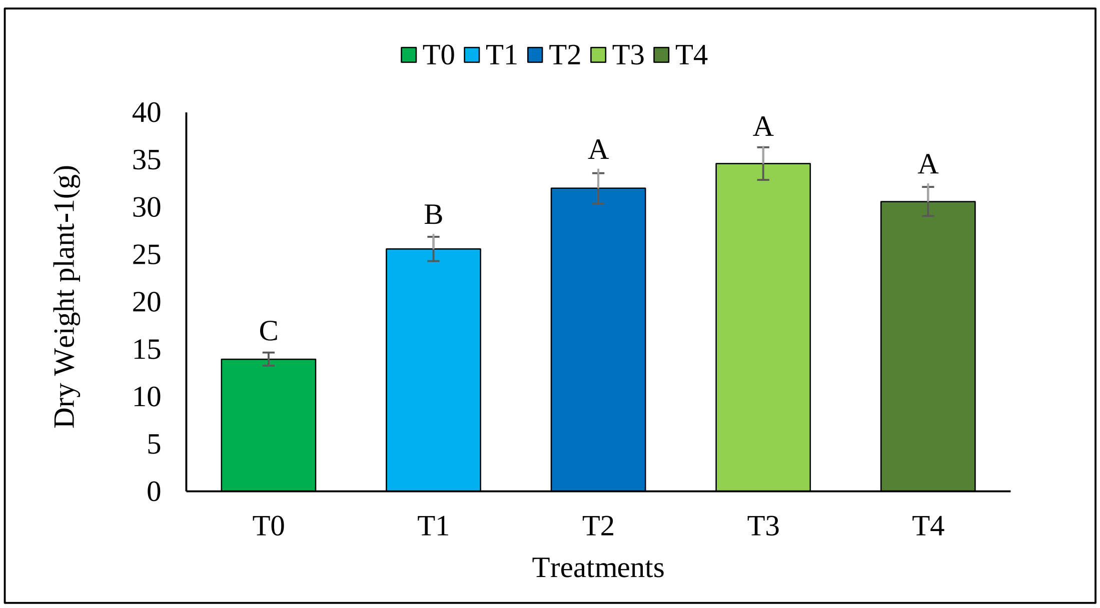


Figure 4: Comparison of fresh weight of plant of T0, T3 and T4 treatments at harvesting

(Here, T0= control; T1= 20% HOW compost + soil; T2= 40% How compost + soil; T3= 50% How compost + soil; T4= Recommended dose of fertilizer)

4.3 Dry Weight plant^{-1}

Dry weight is one of the most important growth determining characteristics. Dry weight varies significantly with the different doses of HOW compost application compared to treatment T1 (Figure 3). In T1, T2 and T3 treatments dry weight gradually increases (T1<T2<T3) with different HOW compost doses compared to the control treatment T0 (13.96 g). Treatment T4 (30.6 g) shows insignificant reduction in dry weight. This reduction maybe for the use of inorganic fertilizers. T3 treatment shows the highest result (34.6 g) followed by T2 (32g) and T4 (30.6 g) and the treatment T0 (13.96 g) shows the lowest result. Treatment T2 (32g) and T4 (30.6 g) are 8% and 12% lower than the treatment T3 (34.6 g) in dry weight respectively. Organic compost helps in accumulation of more dry matter in plant than the inorganic practices. Using organic compost Sing *et. al.*, (2008) observed similar type of results.



*Column with the same letter are not significantly different at 5% level of significance

Figure 5: Effect of different treatments on Dry weight of plant

(Here, T0= control; T1= 20% HOW compost + soil; T2= 40% How compost + soil; T3= 50% How compost + soil; T4= Recommended dose of fertilizer)

Treatment T3 (34.6 g) gained highest dry weight per plant in the experiment. It was 13% higher than the dry weight of treatment T4 (30.6 g) (Figure 6).

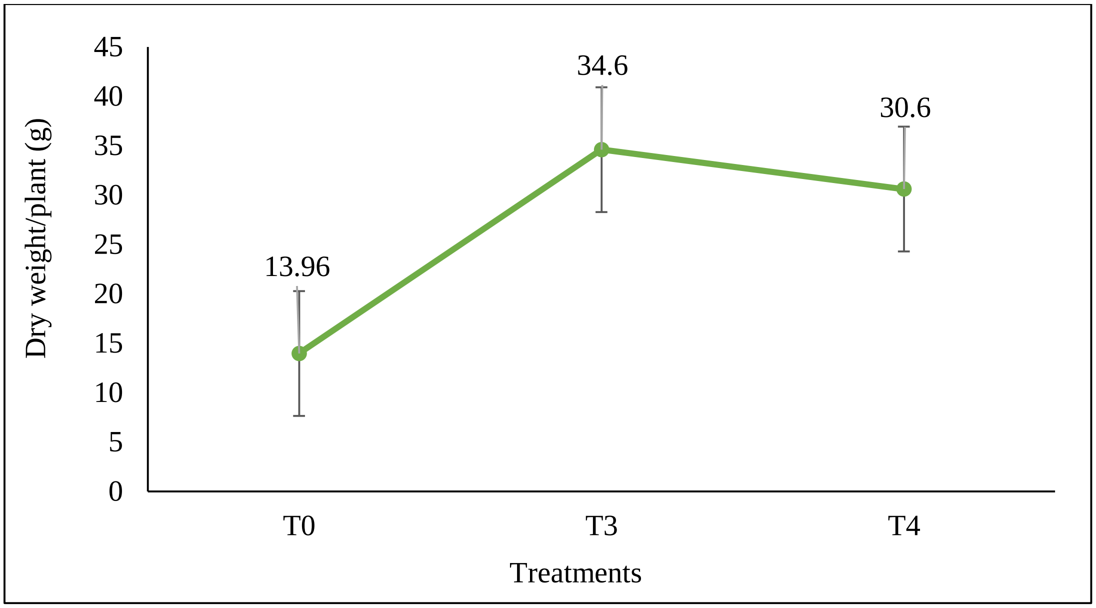
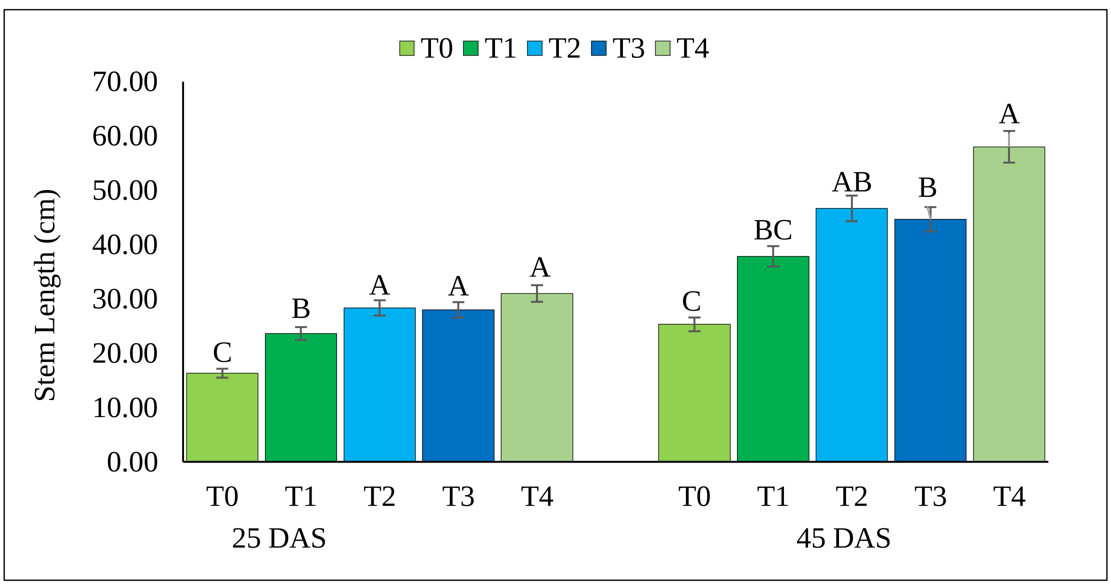


Figure 6: Comparison of dry weight of plant of T0, T3 and T4 treatments at harvesting

(Here, T0= control; T1= 20% HOW compost + soil; T2= 40% How compost + soil; T3= 50% How compost + soil; T4= Recommended dose of fertilizer)

4.4 Stem Length

In case of leafy vegetables stem length is an important attribute in determining the Growth and yield of the crop. Significant changes observed due to the application of different doses of HOW compost compared to T0 (Figure 4) at 25 DAS and harvest data. The stem lengths were insignificantly different in treatment T2, T3 and T4 at 25 DAS data. Stem length increased by 49% in T1 (37.83 cm) treatment, 84% in T2 (46.67 cm) treatment, 76% in T3 (44.67 cm) treatment and 129% in treatment T4 (58 cm) (recommended dose) compared to the treatment T0 (25.33 cm) (control) in the harvest data. T3 and T2 organic treatment gave statistically similar results as their doses had less difference. The length of T3 treatment was only 4% lower the T2. The order of stem length was T4>T2>T3>T1>T0. Treatment T4 (58 cm) showed the highest stem length which was similar to the results of Uddin *et. al.*, (2004) and Ikbal (2008).



*Column with the same letter are not significantly different at 5% level of significance

Figure 7: Effect of different treatments on Stem Length (cm)

(Here, T0= control; T1= 20% HOW compost + soil; T2= 40% How compost + soil;
T3= 50% How compost + soil; T4= Recommended dose of fertilizer
DAS= Days after sowing)

At 25 DAS the highest stem length was obtained by treatment T4 (31 cm) followed by the HOW compost treatment T3 (28 cm). At harvesting treatment T4 (58 cm) showed the highest stem length followed by T2 and T3 (44.67 cm). Treatment T0 (25.33 cm) obtained lowest length (Figure 8).

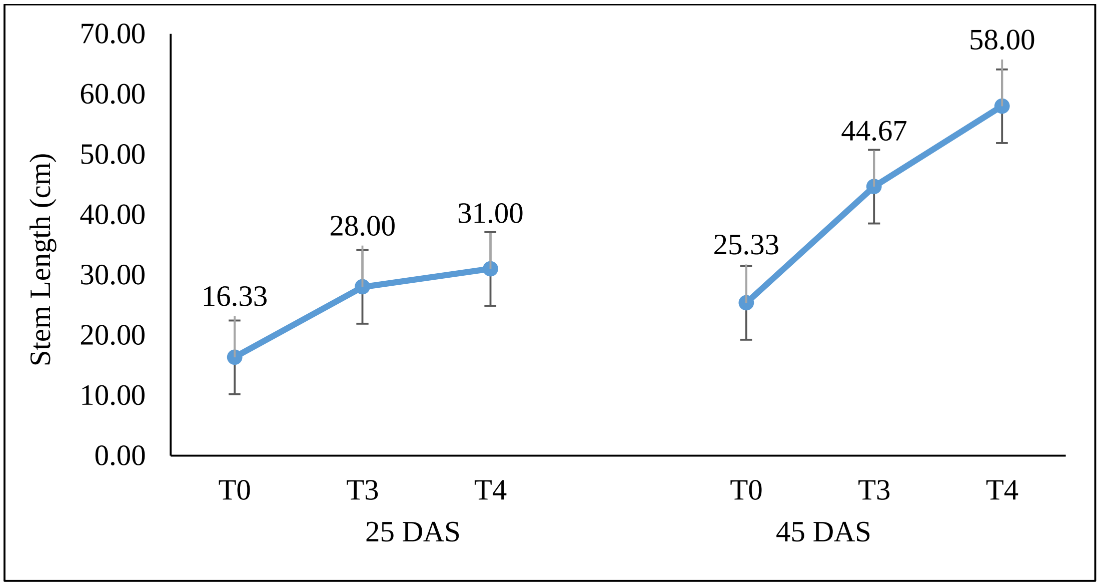
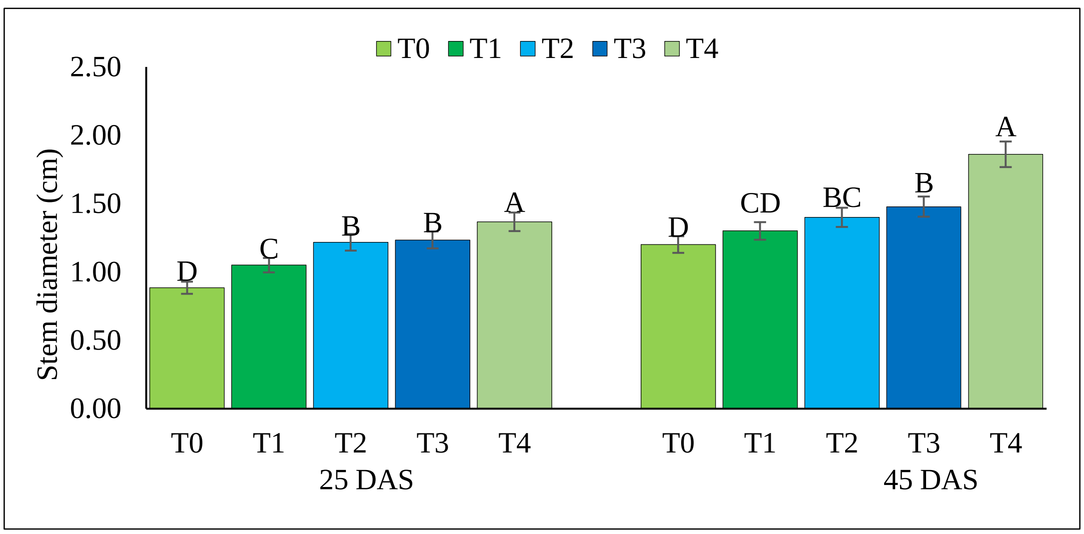


Figure 8: Comparison of stem length of plant of T0, T3 and T4 treatments at 25 DAS and 45 DAS (Harvesting)

(Here, T0= control; T1= 20% HOW compost + soil; T2= 40% How compost + soil;
T3= 50% How compost + soil; T4= Recommended dose of fertilizer
DAS= Days after sowing)

4.5 Stem Diameter

Stem diameter of *Basella alba* showed significant difference with different HOW compost doses (Figure 5). In 25 DAS data all HOW compost treatment T1, T2, T3 and T4 were significantly different compared to the treatment T0 but the HOW compost treatment T2 and T3 were insignificantly different between them. The lowest stem diameter was observed 1.20 cm in treatment T0 and the highest stem diameter was obtained in treatment T4 (1.86 cm) (recommended dose) in harvest data. The order of increment in stem diameter was T4>T3>T2>T1>T0. Treatment T1 (1.30 cm), T2 (1.4 cm) and treatment T3 (1.48 cm) showed gradual increase in stem diameter as the treatments had different amount of organic matter. It was observed that the higher amount of organic matter produced the higher stem diameter and the recommended doses produced the highest stem diameter. Similar type of result was found by Islam *et. al.*, (2011).



*Column with the same letter are not significantly different at 5% level of significance

Figure 9: Effect of different treatments on Stem Diameter (cm)

(Here, T0= control; T1= 20% HOW compost + soil; T2= 40% How compost + soil;
T3= 50% How compost + soil; T4= Recommended dose of fertilizer
DAS= Days after sowing)

At 25 DAS the thickest stem diameter was obtained by treatment T4 (1.37 cm) followed by the HOW compost treatment T3 (1.23 cm). At harvesting treatment T4 (1.86 cm) showed the thickest stem diameter followed by T3 (1.48 cm). Treatment T0 (1.2 cm) obtained lowest stem diameter (Figure 10).

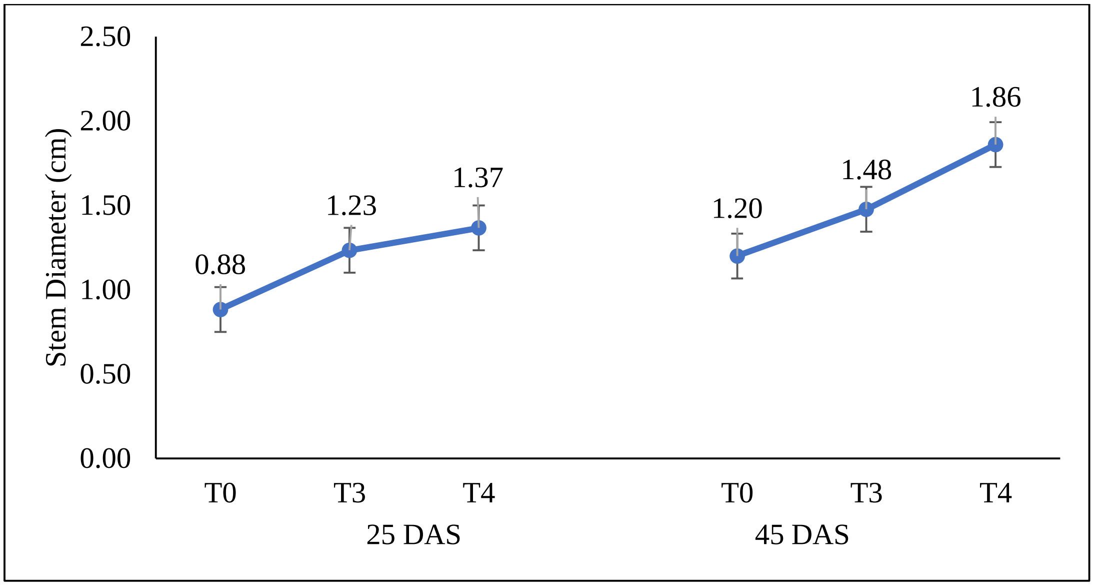
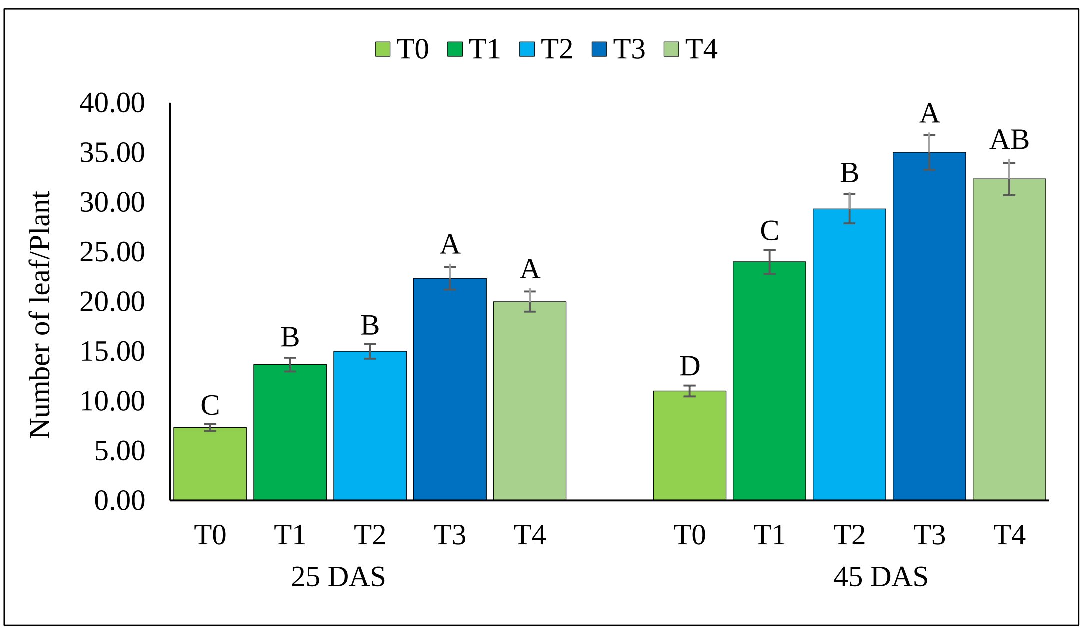


Figure 10: Comparison of stem diameter of plant of T0, T3 and T4 treatments at 25 DAS and 45 DAS (Harvesting)

(Here, T0= control; T1= 20% HOW compost + soil; T2= 40% How compost + soil;
T3= 50% How compost + soil; T4= Recommended dose of fertilizer
DAS= Days after sowing)

4.6 Number of leaves plant^{-1}

In case of leafy vegetables leaf count is the most important growth and yield determining attribute. The number of leaf differ significantly with different compost and fertilizer doses (Figure 6). In 25 DAS and harvest data Treatment T0 produced least number of leaves (11 leaves/plant). The highest leaf number obtained by HOW compost treatment T3 both in 25 DAS and harvest data . This difference may be due to the use of organic fertilizer. The order of leaf number of different treatment was T3>T4>T2>T1>T0, where T4 produced 32 leaves per plant, T2 produced 29 leaves per plant and T1 produced 24 leaves per plant and T0 produced 11 leaves per plant in harvest data. Treatment T3 produced 8% more leaves than the T4 and 16% more leaves than T2 treatment. Uddin *et. al.,* (2004) also reported that organic fertilizer treatments helps in producing more leaves than inorganic fertilizer treatment.



*Column with the same letter are not significantly different at 5% level of significance

Figure 11: Effect of different treatments on Leaf number/plant

(Here, T0= control; T1= 20% HOW compost + soil; T2= 40% How compost + soil;
T3= 50% How compost + soil; T4= Recommended dose of fertilizer
DAS= Days after sowing)

At 25 DAS the highest number of leaf per plant was obtained by HOW compost treatment T3 (22.33) followed by the treatment T4 (20) which was 10.67% more than T4 treatment. At harvesting treatment T3 (35) showed the highest number of leaf per plant followed by treatment T4 (32) which was 9.37% more than T4. Treatment T0 (11) obtained lowest number of leaf per plant (Figure 12).

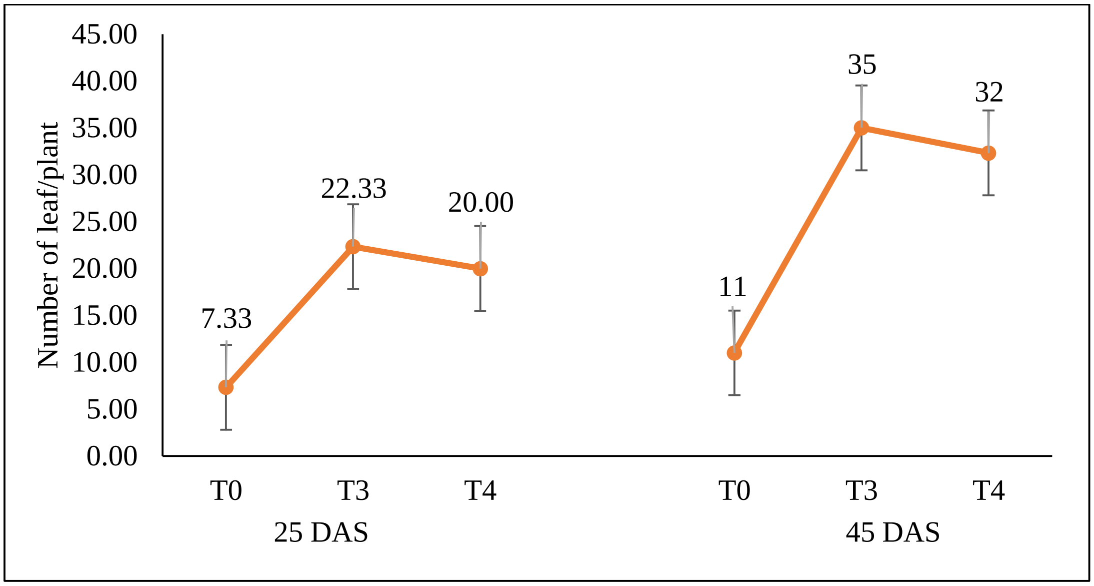
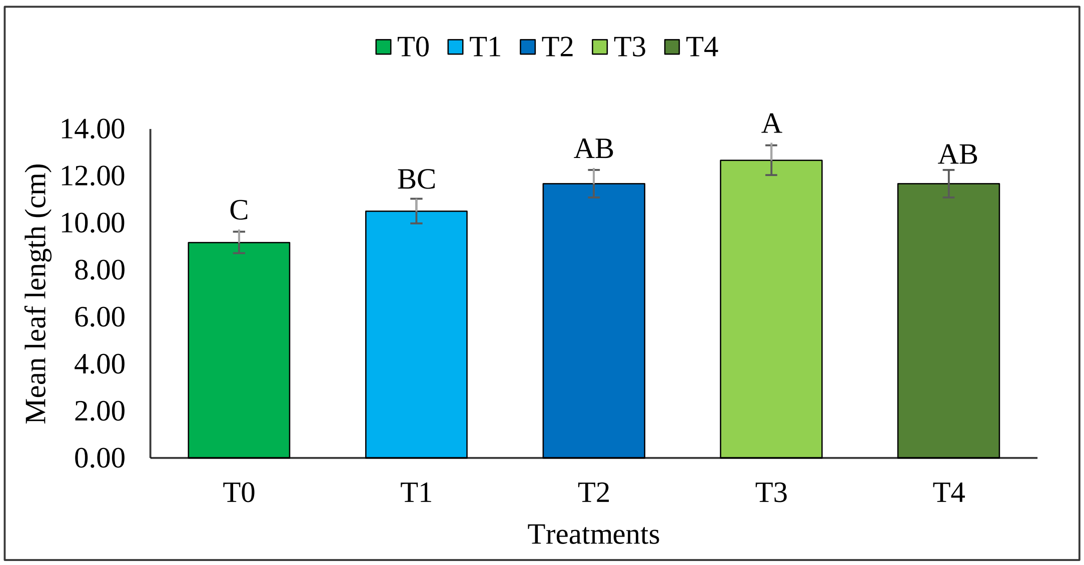


Figure 12: Comparison of number of leaf of plant of T0, T3 and T4 treatments at 25 DAS and 45 DAS (Harvesting)

(Here, T0= control; T1= 20% HOW compost + soil; T2= 40% How compost + soil;
T3= 50% How compost + soil; T4= Recommended dose of fertilizer
DAS= Days after sowing)

4.7 Leaf Length

Large sized leaves are expected in leafy vegetables. In the experiment it was observed that HOW compost treatments produced large sized leaves compared to the control treatment T0 (Figure 7). The longest leaves produced in treatment T3 (12.67 cm) and the shortest leaves in treatment T0. HOW compost treatment T2 and treatment T4 produced more or less same sized leaves. Treatment T1 produced 10.50 cm long sized leaves. Treatment T2 and treatment T4 produced 1 cm shorter leave than the treatment T3. Treatment T1 produced 2.17 cm shorter leaves than T3 treatment. The order of increment of leaf length was T0<T1<T4=T2<T3. Ranasinghe *et. al.*, (2021) reported that the application of organic compost helps to increase the leaf size and other vegetative characters.



*Column with the same letter are not significantly different at 5% level of significance

Figure 13: Effect of different treatments on Leaf length (cm)

(Here, T0= control; T1= 20% HOW compost + soil; T2= 40% How compost + soil; T3= 50% How compost + soil; T4= Recommended dose of fertilizer)

At the time of harvesting the longest leaf was found in the HOW compost treatment T3 (12.67 cm) followed by treatment T4 (11.67 cm). The shortest leaf was found in treatment T0 (9.17 cm) (Figure 14).

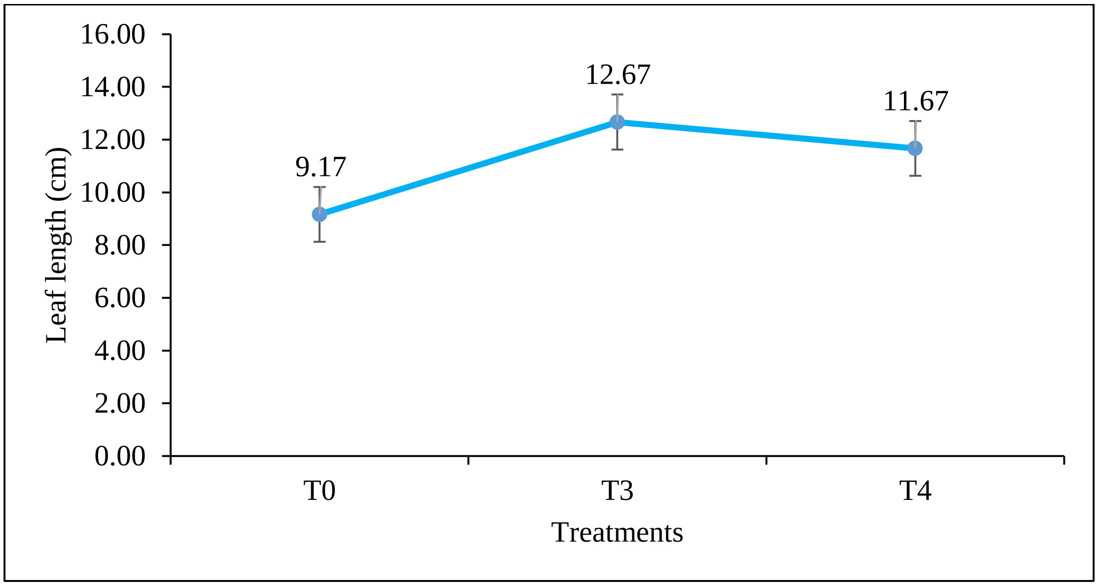
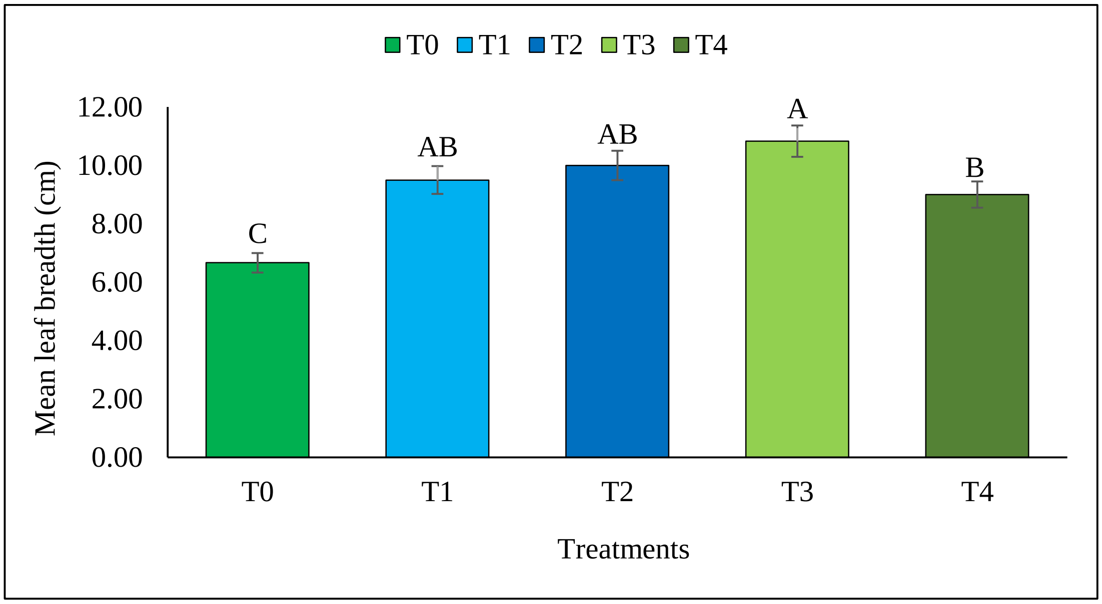


Figure 14: Comparison of leaf length of plant of T0, T3 and T4 treatments at harvesting

(Here, T0= control; T1= 20% HOW compost + soil; T2= 40% How compost + soil; T3= 50% How compost + soil; T4= Recommended dose of fertilizer)

4.8 Leaf Breadth

The leaf breadth of *Basella alba* varied significantly due to different doses of HOW compost compared to T0 (Figure 8). HOW compost treatment T3 (10.83 cm) produced the broadest leaf and the narrowest leaves were produced by the treatment T0 (6.67 cm). Treatment T1, T2 and T2 were statistically similar but treatment T4 was dissimilar to treatment T3. This was due to the organic compost supplied different types of nutrients needed for the vegetative growth of *Basella alba.* Treatment T4 produced 1.83 cm narrower leaves than organic treatment T3 (10.83 cm) which was significantly different. The order of increment of leaf breadth was T0<T4<T1<T2<T3. HOW compost treatment T1 (9.5 cm), T2 (10.00 cm) and T3 (10.83 cm) are non-significantly different among each other. Sing *et. al.*,., (2008) reported that organic treatments help to produce roundish leaf i.e. broader leaves than inorganic treatment.



*Column with the same letter are not significantly different at 5% level of significance

Figure 15: Effect of different treatments on Leaf Breadth (cm)

(Here, T0= control; T1= 20% HOW compost + soil; T2= 40% How compost + soil; T3= 50% How compost + soil; T4= Recommended dose of fertilizer)

At the time of harvesting the broadest leaf was found in the HOW compost treatment T3 (1083 cm) followed by treatment T4 (9 cm). The narrowest leaf was found in treatment T0 (6.67 cm) (Figure 16).

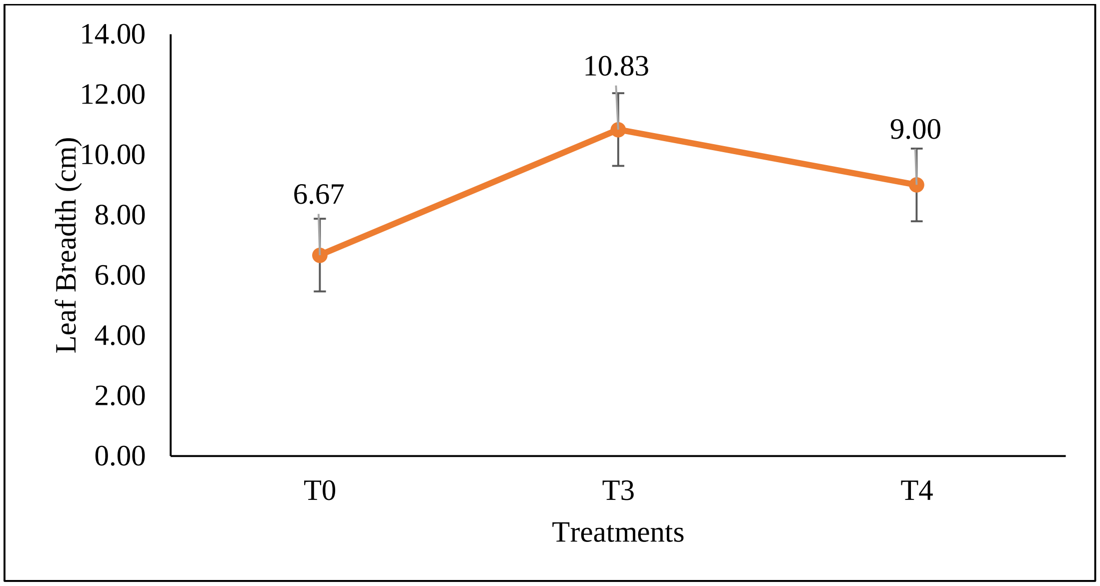
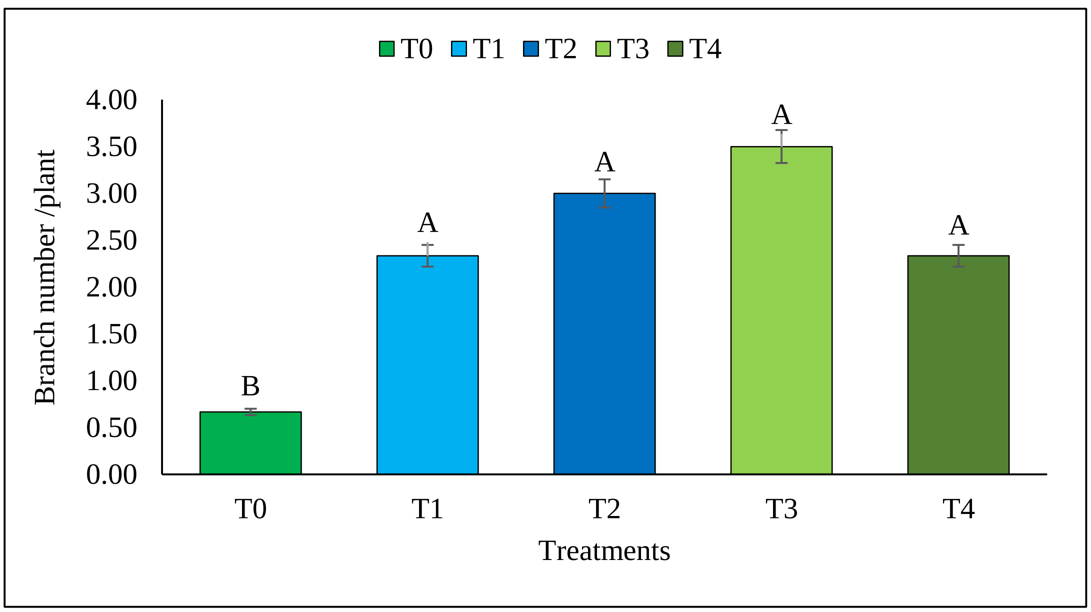


Figure 16: Comparison Leaf breadth of plant of T0, T3 and T4 treatments at harvesting

(Here, T0= control; T1= 20% HOW compost + soil; T2= 40% How compost + soil; T3= 50% How compost + soil; T4= Recommended dose of fertilizer)

4.9 Number of Branches plant^{-1}

More branch will contain more leaves and the leaves are the most important part in terms of leafy vegetables. The number of branches per plant differed significantly with the different dosses of HOW compost and the inorganic treatment compared to the treatment T0 (Figure 9). Treatment T1, T2, T3 and T4 were statistically similar in performance. The maximum number of branches were produced by HOW compost treatment T3 (3.5 per plant) and the minimum number of branches were produced by treatment T0. HOW compost treatment T3 (3.5 per plant), T2 (3.0 per plant), T1 (2.33 per plant) and inorganic treatment T4 (2.33 per plant) are statistically non-significantly similar among each other. Ranasinghe *et. al.,.*, (2021) observed that organic matter helps to produce more branches and to improve other vegetative parameters.



*Column with the same letter are not significantly different at 5% level of significance

Figure 17: Effect of different treatments on Leaf Breadth (cm)

(Here, T0= control; T1= 20% HOW compost + soil; T2= 40% How compost + soil; T3= 50% How compost + soil; T4= Recommended dose of fertilizer)

At the time of harvesting the maximum branching was found in the HOW compost treatment T3 (3.5) followed by treatment T4 (2.33). The minimum branching was found in treatment T0 .67) (Figure 18).

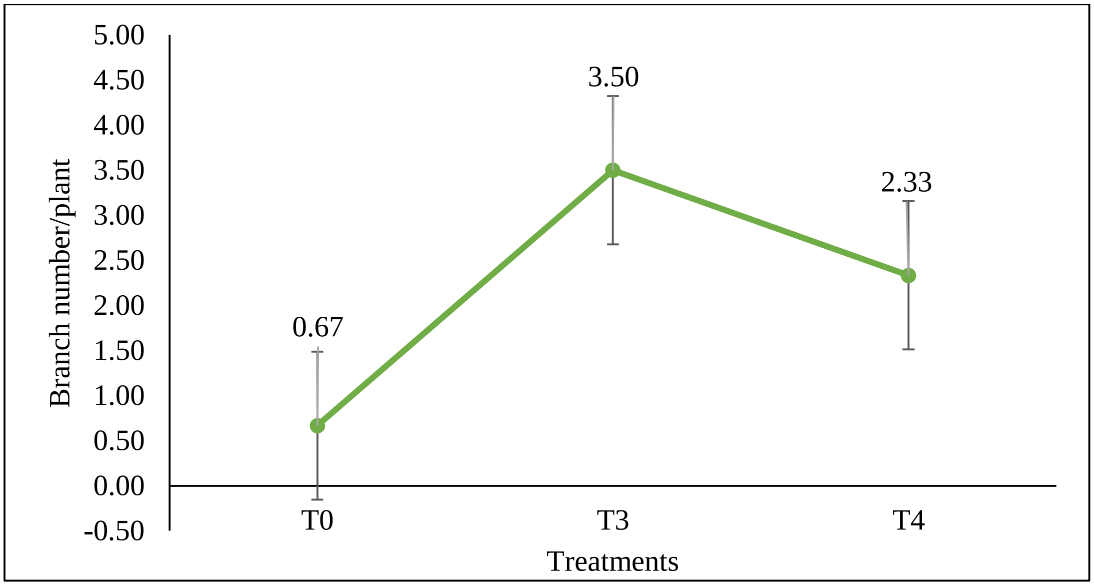


Figure 18: Comparison of number of branches per plant of T0, T3 and T4 treatments at harvesting

(Here, T0= control; T1= 20% HOW compost + soil; T2= 40% How compost + soil; T3= 50% How compost + soil; T4= Recommended dose of fertilizer)

CHAPTER 5

SUMMARY AND CONCLUTION

SUMMARY

A pot experiment was conducted using HOW compost to observe the changes of growth, yield of Indian spinach (*Basella alba*) under five different treatments and three replications to find out the effectiveness of HOW compost. The experiment was conducted at the field laboratory of Agroforestry and Environmental Science, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh, during the months from March 27 to May 17, 2020. The five treatments of the experiment were (1) T0: only the field soil (control), (2) T1: 20% parts HOW compost of the total volume of media, (3) T2: 40% parts HOW compost of the total volume of media, (4) T3: 50% HOW compost of the total volume of media, and (5) T4: Recommended dose (according to the recommended dose of BARI for vegetable production). The collected data were statistically analyzed for the evaluation of different growth and yield measuring attributes.

Plant fresh weight of *Basella alba* differ significantly by the application of different doses of HOW compost compared to T0 (control). Treatment T4 (recommended dose) gained the highest fresh weight per plant whereas T_0 (control) treatment had the lowest fresh weight per plant. Treatment T3 (160 g) and T2 (168 g) showed the close response to the organic fertilizer doses (T3>T2). T3 treatment gained 5% more fresh weight than T2 treatment. And the T4 (combined) treatment gained 18% more fresh weight per plant than the T3 organic treatment. The order of increment of fresh weight of different treatment was T0<T1<T2<T3<T4. Dry weight is one of the most important growth determining characteristics. Dry weight varies significantly with the different doses of HOW compost application. In T1, T2 and T3 treatments dry weight gradually increases (T1<T2<T3) with different HOW compost doses

compared to the control treatment T0 (13.96 g) but the combined T4 (30.6 g). Treatment shows significant reduction in dry weight. This reduction maybe for the use of inorganic fertilizers. T3 treatment shows the highest result (34.6 g) followed by T2 (32g) and T4 (30.6 g) and the treatment (control) T0 (13.96 g) shows the lowest result. Treatment T2 (32g) and T4 (30.6 g) are 8% and 12% lower than the treatment T3 (34.6 g) in dry weight respectively. In case of leafy vegetables stem length is an important attribute in determining the Growth and yield of the crop. Significant changes observed due to the application of different doses of HOW compost compared to (control) T0 at 25 DAS and harvest data. The stem lengths were insignificantly different in treatment T2, T3 and T4 at 25 DAS data. Stem length increased by 49% in T1 (37.83 cm) treatment, 84% in T2 (46.67 cm) treatment, 76% in T3 (44.67 cm) treatment and 129% in treatment T4 (58 cm) (recommended dose) compared to the treatment T0 (25.33 cm) (control) in the harvest data. T3 and T2 organic treatment gave more or less similar results as their doses had less difference. The length of T3 treatment was only 4% lower the T2. The order of stem length was T4>T2>T3>T1>T0. Stem diameter of *Basella alba* showed significant difference with different HOW compost doses. In 25 DAS data all HOW compost treatment T1, T2, T3 and T4 (recommended dose) were significantly different compared to the treatment T0 (control) but the HOW compost treatment T2 and T3 were insignificantly different between them. The lowest stem diameter was observed 1.20 cm in treatment T0 (control) and the highest stem diameter was obtained in treatment T4 (1.86 cm) (recommended dose) in harvest data. The order of increment in stem diameter was T4>T3>T2>T1>T0. Treatment T1 (1.30 cm), T2 (1.4 cm) and treatment T3 (1.48 cm) showed gradual increase in stem diameter as the treatments had different amount of organic matter. In case of leafy vegetables leaf count is the most important growth and yield determining attribute. The number of leaf differ significantly with different compost and fertilizer doses. In 25 DAS and harvest data Treatment T0 (control) produced least number of leaves (11 leaves/plant). The highest leaf number obtained by HOW compost treatment T3 both in 25 DAS and harvest data. This difference may be due to the use of organic fertilizer. The order of leaf number of different treatment was T3>T4>T2>T1>T0, where T4 produced 32 leaves per plant, T2 produced 29 leaves per plant and T1 produced 24 leaves per plant and T0 produced 11 leaves per plant in harvest data. Treatment T3 produced 8% more leaves than the T4 (recommended dose) and 16% more leaves than T2 treatment. In the experiment it was observed that HOW compost treatments produced large sized leaves compared to the control treatment T0. The longest leaves produced in treatment T3 (12.67 cm) and the shortest leaves in treatment T0 (control). Treatment T1 produced 10.50 cm long sized leaves. Treatment T2 and treatment T4 produced 1 cm shorter leave than the treatment T3. Treatment T1 produced 2.17 cm shorter leaves than T3 treatment. The order of increment of leaf length was T0<T1<T4=T2<T3. The leaf breadth of *Basella alba* varied significantly due to different doses of HOW compost compared to T0 (control). HOW compost treatment T3 (10.83 cm) produced the broadest leaf and the narrowest leaves were produced by the treatment T0 (6.67 cm) (control). This was due to the organic compost supplied different types of nutrients needed for the vegetative growth of *Basella alba.* Treatment T4 (recommended dose) produced 1.83 cm narrower leaves than organic treatment T3 (10.83 cm) which was significantly different. The order of increment of leaf breadth was T0<T4<T1<T2<T3. HOW compost treatment T1 (9.5 cm), T2 (10.00 cm) and T3 (10.83 cm) are non-significantly different among each other. The number of branches per plant differed significantly with the different dosses of HOW compost and the inorganic treatment compared to the treatment T0 (control). The maximum number of branches were produced by HOW compost treatment T3 (3.5 per plant) and the minimum number of branches were produced by treatment T0 (control). HOW compost treatment T3 (3.5 per plant), T2 (3.0 per plant), T1 (2.33 per plant) and inorganic treatment T4 (2.33 per plant) (recommended dose) are statistically similar among each other.

CONCLUTION

Household waste management is very important to keep the environment free from pollution. Making compost using household organic waste and using the compost to grow organic vegetables for family consumption can be the best way to household waste management. This is the best way to reduce pollution caused by household wastes. Indian spinach (*Basella alba*) is a popular leafy vegetable which can be grown in kitchen yard garden or in rooftop garden using HOW compost. Considering the growth and yield attributes of Indian spinach grown by using HOW compost T3 treatment showed the best performance followed by T2 and T1. So, to produce organic and safe vegetables in small scale T3 treatment will be best.

RECOMMENDATIONS

The following suggestions and recommendations associated to this experiment should be followed for further research events related to this alike topic-

- ❖ Further growth and yield based researches on this similar topic should be done to get more accurate data.
- ❖ More researches on chemical composition and nutrient content should be undertaken.
- ❖ More researches should be carried out using different varieties to find out the best variety for organic cultivation.

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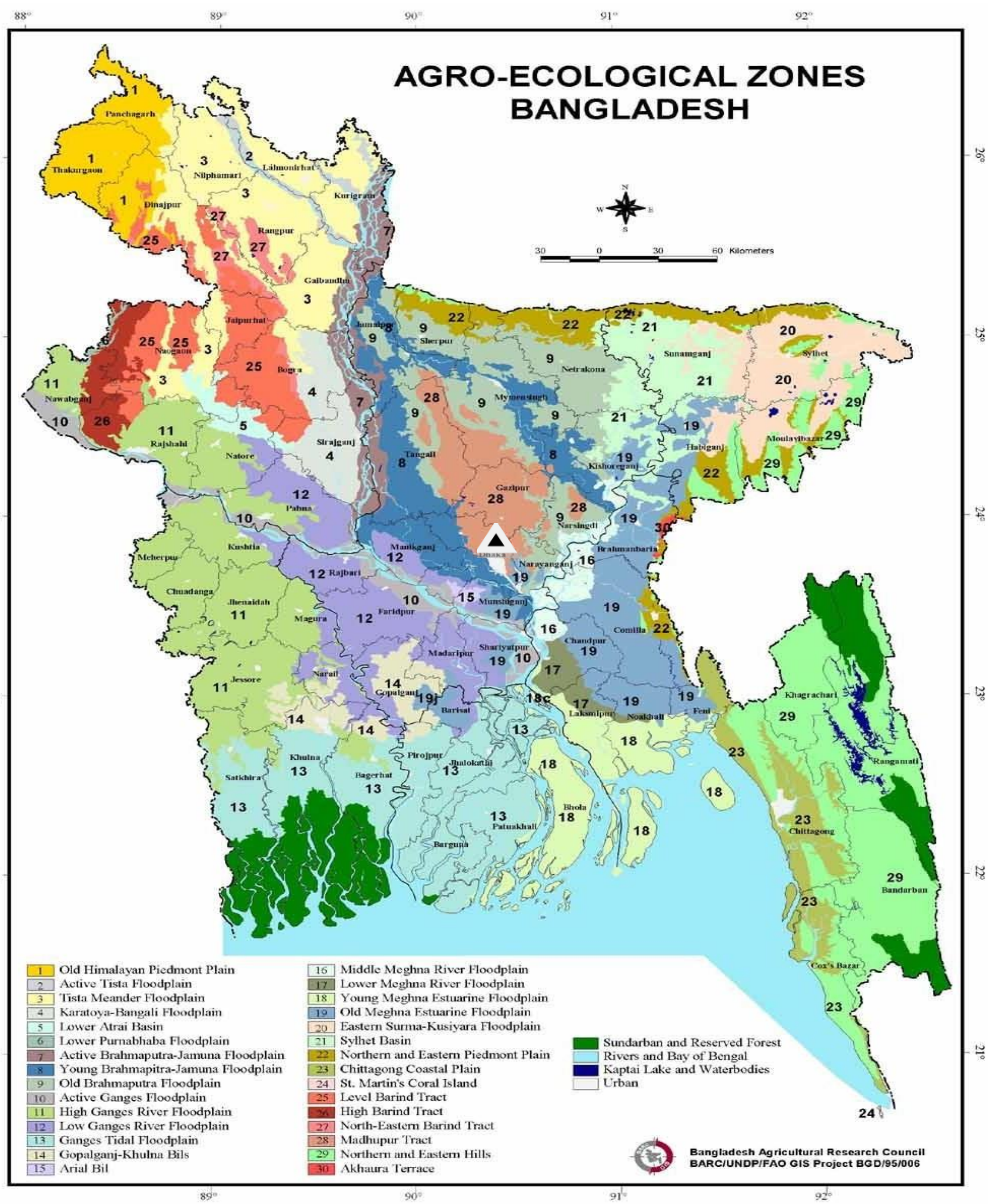
APPENDICES

Appendix 1. Map showing the experimental site under the study



▲ The experimental site under study

Appendix 2. The mechanical characteristics of soil of the experimental site as observed prior to experimentation (0 -15 cm depth).

Mechanical composition:

Particle size	**Constitution**
Texture	Loamy
Sand	40%
Silt	40%
Clay	20%

Appendix 3: Chemical composition of soil

Soil characters	**Value**
Organic matter	1.44 %
Potassium	0.15 meq/100 g soil
Phosphorus	22.08 µg/g soil
Magnesium	1.00 meq/100 g soil
Total nitrogen	0.072
Copper	3.54 µg/g soil
Sulphur	25.98 µg/g soil
Calcium	1.00 meq/100 g soil
Boron	0.48 µg/g soi
Zinc	3.32 µg/g soil
Iron	262.6 µg/g soil
Manganese	164 µg/gsoil

Source: Soil Resources Development Institute (SRDI), Khamarbari, Dhaka

Appendix 4: Germination Percentage (%)

Treatment	R1	R2	R2	Mean
T0	76	64	68	69.33 B
T1	84	78	72	78.00 B
T2	100	92	100	97.33 A
T3	92	100	100	97.33 A
T4	100	92	92	94.67 A
CV%				6.00
$LSD_{(0.05)}$				9.53

Appendix 5: Mean data of different growth and yield determining characteristics for different doses of HOW compost and control treatments with replications.

Treatment	Fresh Wt/plant (gm)	Plant Height(Cm)		Stem diameter (cm)		Number of leaf/plant	
		30 DAS	45DAS	30 DAS	45DAS	30 DAS	45DAS
T0R1	99	18	28	0.85	1.10	6.00	10
T0R2	64	15	25	0.90	1.30	9.00	12
T0R3	61	16	23	0.90	1.20	7.00	11
T1R1	128	23	41	1.05	1.35	15.00	24
T1R2	132	24	35	1.00	1.30	13.00	26
T1R3	137	24	38	1.10	1.25	13.00	22
T2R1	156	28	41	1.20	1.40	16.00	32
T2R2	160	27	45	1.25	1.50	15.00	29
T2R3	164	30	54	1.20	1.30	14.00	27
T3R1	180	27	38	1.20	1.37	22.00	35
T3R2	167	26	52	1.25	1.53	20.00	33
T3R3	172	31	44	1.25	1.53	25.00	37
T4R1	220	34	72	1.50	1.90	21.00	37
T4R2	188	29	49	1.30	1.88	19.00	28
T4R3	205	30	53	1.30	1.80	20.00	32

Appendix 5(continued). Mean data of different growth and yield determining characteristics for different doses of HOW compost and control treatments with replications.

Treatment	Leaf length (cm)	Leaf breadth (cm)	Branch number/plant	Dry Wt/plant (g)
T0R1	9.50	6.00	1.00	18.81
T0R2	9.00	7.50	0.00	10.88
T0R3	9.00	6.50	1.00	12.2
T1R1	9.00	10.00	2.00	25.6
T1R2	11.50	9.00	3.00	23.76
T1R3	11.00	9.50	2.00	27.4
T2R1	11.00	10.00	2.00	31.2
T2R2	12.00	11.00	3.00	32
T2R3	12.00	9.00	4.00	32.8
T3R1	14.00	11.50	3.00	36
T3R2	11.00	10.50	4.00	33.4
T3R3	13.00	10.50	3.50	34.4
T4R1	13.00	10.00	3.00	33
T4R2	11.00	9.00	2.00	30.08
T4R3	11.00	8.00	2.00	28.7

Appendix 6: Mean data with CV% and LSD (0.05) of different growth and yield determining characteristics for different doses of HOW compost and control treatments.

Treatments	Mean Fresh wt/plant (gm)	Mean Stem Length (cm)		Mean stem diameter (cm)		Mean leaf number/plant	
		25DAS	45DAS	25DAS	45DAS	25DAS	45DAS
T0	74.67 D	16.33 C	25.33 C	0.88 D	1.20 D	7.33 C	11.00 D
T1	132.33 C	23.66 B	37.83 BC	1.05 C	1.3 CD	13.66 B	24.00 C
T2	160.00 B	28.33 A	46.67 AB	1.21 B	1.4 BC	15.00 B	29.33 B
T3	168.33 B	28.00 A	44.67 B	1.23 B	1.47 B	22.33 A	35.00 A
T4	204.33 A	31.00 A	58.00 A	1.37 A	1.86 A	20.00 A	32.33 AB
CV%	8.40	7.65	16.92	5.27	5.86	9.89	10.14
LSD(0.05)	22.75	3.55	13.01	0.11	0.15	2.82	4.86

*Means with the same letter are not significantly different along the vertical column.

Appendix 6 (Cont'd): Mean data with CV% and LSD (0.05) of different growth and yield determining characteristics for different doses of HOW compost and control treatments.

Treatments	Mean leaf length (cm)	Mean leaf breadth (cm)	Mean branch number/plant	Mean dry Wt./plant (g)
T0	9.16 C	6.66 C	0.67 B	13.96 C
T1	10.5 BC	9.5 AB	2.33 A	25.59 B
T2	11.66 AB	10 AB	3.00 A	32.00 A
T3	12.66 A	10.83 A	3.50 A	34.60 A
T4	11.66 AB	9.00 B	2.33 A	30.60 A
CV%	9.70	8.65	28.34	8.74
LSD(0.05)	1.97	1.45	1.22	4.35

*Means with the same letter are not significantly different along the vertical column.

Appendix 7: One-Way **ANOVA** Table for all the growth and yield determining parameters

Table 1: One-Way ANOVA and LSD for Fresh Weight/Plant (g)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	28685.733	4	7171.433	45.853	.00001
Within Groups	1564.000	10	156.400		
Total	30249.733	14			

Table 2:One-way ANOVA for Dry Weight/ Plant (g)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	801.05	4	200.26	35.077	.00001
Within Groups	57.09	10	5.71		
Total	858.14	14			

Table 3: One-Way ANOVA for Stem Length (cm) [25 DAS]

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	395.733	4	98.933	26.035	.00003
Within Groups	38.000	10	3.800		
Total	433.733	14			

Table 4: One-Way ANOVA for Stem Length (cm) [Harvest]

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1736.333	4	434.083	8.393	.003
Within Groups	517.167	10	51.717		
Total	2253.500	14			

Table 5: One-Way ANOVA for Stem Diameter (cm) [25 DAS]

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.418	4	0.105	28.523	.00002
Within Groups	.037	10	0.004		
Total	.455	14			

Table 6: One-Way ANOVA for Stem Diameter (cm) [Harvest]

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.769	4	.192	28.405	.00001
Within Groups	0.068	10	.007		
Total	0.836	14			

Table 7: One-Way ANOVA for Number of leaf plant^{-1} [25DAS]

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	411.333	4	102.833	42.847	.000003
Within Groups	24.000	10	2.400		
Total	435.333	14			

Table 8: One-Way ANOVA for Number of leaf plant^{-1} [Harvest]

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1082.00	4	270.50	37.92	.00001
Within Groups	71.33	10	7.13		
Total	1153.33	14			

Table 9: One-Way ANOVA for Leaf Length (cm)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	21.567	4	5.392	4.621	.023
Within Groups	11.667	10	1.167		
Total	33.233	14			

Table 10: One-Way ANOVA for Leaf Breadth (cm)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	29.567	4	7.392	11.671	.001
Within Groups	6.333	10	.633		
Total	35.900	14			

Table 11: One-Way ANOVA for Number of branch plant^{-1}

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	13.733	4	3.433	7.630	.004
Within Groups	4.500	10	.450		
Total	18.233	14			

Appendix 8. Photographs of plants of different stages

Plate 1. Early stage of seedlings

Plate 2. After weeding operation

Plate 3. More infected T0 and T4 (control) treatments with cercospora leaf spot

Plate 4. Less infected T1 and T2 treatment with Cercospora leaf spot

Plate 5. Less infected T3 treatment with cercospora leaf spot