EFFECT OF COMPOST ON GROWTH AND ROOT ARCHITECTURE OF *Melia azedarach* L. SEEDLINGS

A THESIS

BY

MD. GOLAM RABBANI
Registration No. 1605108
Session: 2016
Thesis Semester: January-June, 2017

MASTER OF SCIENCE (M.S.)
IN
AGROFORESTRY AND ENVIRONMENT

DEPARTMENT OF AGROFORESTRY AND ENVIRONMENT

HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY, DINAJPUR

JUNE 2017

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Submitted to the Department of Agroforestry and Environment, Hajee Mohammad Danesh Science and Technology University, Dinajpur in partial fulfillment of the requirements of the degree of

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Approved as to style and contents by

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Dr. Md. Shoaibur Rahman
Supervisor

____

Prof. Dr. Md. Shafiqul Bari
Co-Supervisor

____

(Prof. Dr. Md. Shafiqul Bari)
Chairman of Examination Committee
and
Chairman
Department of Agroforestry and Environment
Hajee Mohammad Danesh Science and Technology University, Dinajpur.

June 2017

Dedicated

To

My Beloved Parents

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EFFECT OF COMPOST ON GROWTH AND ROOT ARCHITECTURE OF *Melia azedarach* L. SEEDLINGS

ABSTRACT

An experiment was conducted at the Agroforestry and Environment of Research Field, Hajee Mohammad Danesh Science and Technology University, Bangladesh during October 2016 to April 2017 to find out the effect of compost on the germination, shoot growth and root architecture of Ghora neem (*Melia azedarach* L.) seedlings. There were seven (07) compost preparation with control (soil) viz. T_1 (kitchen waste+ cow dung), T_2 (kitchen waste + poultry manure), T_3 (kitchen waste+ cow dung+ poultry manure), T_4 (poultry manure+ ash), T_5 (poultry manure+ ash+ saw dust), T_6 (poultry manure+ saw dust) and T_7 (only soil). The experiment was laid out in Complete Randomized Design (CRD) with four replications. The experiment was conducted in mud containers in the open field condition. The experimental results revealed that germination % of seed and number of germinated shoots were positively affected by different composts. Ghora neem seeds showed better germination in almost all the compost treatments except T_1 compared to control. The highest germination % of Ghora neem seeds was recorded in T_4 followed by T_3 (50%), T_6 (43.75%), T_5 (37.5%), T_2 (31.25%), and lowest germination percentage (25%) was recorded in treatment T_1. Incase of the shoot and root morphological traits, the number of leaves and root length varied due to different composts. Other parameters of Ghora neem seedlings shoot height, root collar diameter, shoot dry biomass, root dry biomass, central root length, quality index were found statistically insignificantly. The highest number of leaves of Ghora neem seedlings was recorded in treatment of T_4 and the lowest in T_2. On the other hand, the highest shoot/root ratio found in T_5 and the shortest length was recorded in T_2. Shoot and root dry biomass was found insignificantly due to different compost application. Root architectural analyses showed that the length of first order lateral roots (FOLR) was recorded same after 1, 2 ,3 and 4 months but their diameter and number increased after 2, 3 and 4 months than that of 1 month. From the study, it can be concluded that T_4 i.e. poultry manure+ ash can be used to break the dormancy of hard seed coat of Ghora neem seeds and subsequent better growth of the seedlings. So, the raise and plantation of Ghora neem seedling the compost made by poultry manure with ash may be a good manuring.

CONTENTS

CONTENTS (Cont'd.)

CONTENTS (Cont'd.)

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

CHAPTER 1

INTRODUCTION

LIST OF APPENDICES

CHAPTER 1

INTRODUCTION

In many countries, a large population of municipal waste is not disposed properly posing a potential environmental threat due to presents of pathogens and toxic pollutants (Darby *et al*., 2006; De Araujo *et al*., 2009). Landfill is problematic as it leads to pollution problems such as leachate and landfill gases, especially when disposing municipal solid waste with high moisture and organic content (CIWMB, 2004). Organic municipal waste and other organic material such as manure can be composted. Composting is an aerobic process during which the organic matter decomposed to humus-like substances. The volume of the material decreases during composting and the resulting compost is nutrient rich and more stable than the original material (feedstock) and can improve soil quality and productivity as well as sustainability of agricultural production (Barral *et al*., 2009; Farrell and Jones, 2009). The cost of chemical fertilizers and the potential environmental risk posed by overuse have renewed the interest in using soil organic matter amendments such as plant residues, manures and composts.

However compost properties vary widely depending on feed stocks and composting procedure (Bernal *et al.,* 2009; Bertoldia *et al.,* 1983). Efficient and optimal use of composts relies on a better understanding of the relationship between compost properties and their effect on soil, how this changes over time and it is modulated by soil type.

In Bangladesh, public forest lands account for about 14.9% and the village forests for another 1.8% of the area of the country (FAO, 2000). Though we have total 16.9 % forest lands officially, but it is assumed that there is only 7-8% tree coverage. Due to over population and management problems natural forests are decreasing day by day. To meet the high demand of wood, government is encouraging social forestry and agroforestry practices through people's participation (Alam *et al.,* 2008; Safa, 2004; Nath *et al*., 2000). In this case, choice of species for practicing agroforestry is very much important.

Ghora neem (*Melia azedarach* L.) is a medium sized to 20 m tall tree with a diameter to 60 cm (Gupta, 1993), but in Australia it grows to a large tree up to 45 m tall and 1.2 m in diameter in moist closed forest (Doran and Turnbull, 1997) is widely used in agroforestry system in Bangladesh for its deciduous nature and small crown. It has a shallow root system (Cao *et al.*, 2012). The bark is grey –brown and smooth, becoming thick and longitudinally fissured with age .The leaves are bipinnate, wholly or partly tripinnate, more or less opposite.

Ghora neem (*Melia azedarach* L) is usually deciduous during winter except in some humid tropic locations it is evergreen. The old leaves generally shed during December-January with the new flush from March- May. Flowers appear from March- April and fruit ripening in September - October. Fruits remain on the tree in yellow clusters during the next flowering season (Ahmad, 2007).

Ghora neem (*Melia azedarach* L) is widely distributed throughout the tropical, sub-tropical and warm temperate regions. It is grown throughout the Middle East, Southeast Asia, Bangladesh, India, China, west Indies, Southern United states and Mexico, Argentina and Brazil, West and east Africa, the pacific region including Papua New Guinea, Solomon Islands and Australia (NAS, 1983). Ghora neem is naturalized and occurs in most of the districts of Bangladesh. More commonly found in North Bengal, usually planted as roadside avenue trees along highways, railway lines, in parks and gardens. Also found in forest plantations in Sylhet, Chittagong, Dhaka, Tangail, Mymensign and Dinajpur (Das and Alam, 2001).

Ghora neem is drought hardy with an annual rainfall ranging from 600- 2000 mm. It grows on a wide range of soils, but best growth is obtained on well- drained, deep, sandy loam while shallow gravelly soils stunt the growth (Doran and Turnbull, 1997). The species tolerates shallow soils, saline and strongly alkaline soils, but not very acid soils. It is commonly found along stream banks, in valleys and on the lower slopes of coastal ranges in Australia. It is found on poor, marginal, sloping and stony ground. In India, it occurs in the Himalayas up to 1800 m elevation and in Pakistan at altitudes between 700 and 1000 m (Ajayi, 2007).

Ghora neem is a useful tree for farm and amenity planting, shade, including areas subject to drought conditions. It is also suitable for use in windbreaks and in avenue planting. It has been widely attributed with medicinal qualities and contains compounds with anti-feedant and growth-disruption properties in insects. Extracts from the fruits have long been used as an insecticide for plants. The leaves, bark and fruits are placed inside books and woolen garments repel insects. Bark, leaves and roots have been used for medicinal purposes (Bullangpoti *et al.,* 2012).

Agroforestry is a new name practice age-old. It is now an integral part of the traditional farming systems of Bangladesh. Due to limited knowledge of tree-crop interaction, people sometimes are getting low income from the agroforestry practices. Agriculture and forestry were considered before as two distinct areas but these practices are now considered as complementary. This was brought by the increasing realization that agroforestry can become an important component of ecological, social, and economic development efforts.

Ghora neem is a fast growing tree which is using in agroforestry system to get maximum benefit. But it is unknown to the contribution of compost for growth and development of the tree. Therefore, it is necessary to find out the effect of compost on this tree to get total higher yield. Both tree and compost selection depends on their importance. Growth will be hampered if one component inhibits others. Considering the above facts the present study was undertaken to satisfy the compost on the germination and root-shoot growth of Ghora neem seedling at the nursery level.

Objectives:

i. To find out the effect of compost on the germination of Ghora neem (*Melia azedarach* L) seeds.
ii. To measure the effect of compost on the shoot development and root architecture of Ghora neem (*Melia azedarach* L) seedlings.
iii. To determine the effect of compost on the biomass allocation of Ghora neem (*Melia azedarach* L) seedlings.

CHAPTER 2

REVIEW OF LITERATURE

CHAPTER 2

REVIEW OF LITERATURE

The available literature related to the present study are thoroughly reviewed and presented in this chapter under different sub headings.

2.1 Concept of Agroforestry

Agroforestry is an old system although its emergence as an academic discipline is quite new. Agroforestry practices combine agriculture and forestry on the same piece of land. Agroforestry system is defined as the sustainable management system for land that increases overall production, combines agricultural crops, trees and forest plants and/or animals simultaneously or sequentially and applies management practices, which are compatible with the cultural patterns of a local population (Bene *et al.*, 1977).

Saxena (1984) pointed out that agroforestry utilizes the inter space between tree rows for intercropping agricultural crops and that does not impair the growth and development of the trees but enables farmers to derive extra income in addition to benefits accrued from the use of fuel and timber from trees.

Nair (1977) defined agroforestry as a land use system that integrates trees, crops and animals in a way, which is scientifically sound, ecologically desirable, practically feasible and socially acceptable to the farmers.

King (1978) stated that agroforestry might be considered to be practiced whenever trees and agricultural crops are grown in mixture, provided that the combined widths of the rows of agricultural crops do not exceed the heights of the forest trees at maturity and provided further that the combined widths of rows of forest trees do not exceed the height of the tree crops at maturity or at some selected rotations.

It was hypothesized by Nair (1987) that an agroforestry system can play an important role in improving soil fertility by (i) increasing organic matter content of soil through addition of leaf' litter, pruning and other biomass (ii) efficient nutrient recycling within the system, (iii) biological N_2 fixation in case of leguminous shrubs and tree and (iv) possible complementary interactions among associated species due to differences in canopy structures, root systems and active zones of water-nutrient absorptions.

A widely used definition given by the International Council for Research in Agroforestry (ICRAF) is that agroforestry is a collective name for all land use system and practices where woody perennials are deliberately grown on the same form of spatial mixtures or in temporal sequences. There must be significantly ecological and economic interactions between woody and non woody components (Nair, 1987).

According to Solanki (1998) agroforestry can significantly contribute in increasing demands of fuel wood, fodder and cash flows and infrastructures in many developing countries. He also stated that agroforestry has high potential to simultaneously satisfy 3 important objectives: (i) protecting and stabilizing the ecosystems, (ii) producing a high level of output of economic goods (fuel, fodder, small timber, organic fertilizer etc.) and (iii) producing stable employment, improved income and basic material to rural populations.

Agroforestry does not mean planting trees in the fields or other places; rather it provides farmers with an effective land management system that can ensure more production in a balanced ecological environment (Haque, 1996).

From the bio-economic point of view, Harou (1983) stated that agroforestry combines agriculture and tree crop farming system that enables it farmer or land user to make more effective use of his land which may yield a higher net economic return on a sustainable basis.

A common hypothesis is strongly implied to the agroforestry systems that integration of trees with annual crops improves the chemical properties of the soil (Von Maydell, 1987).

Ong (1988) reported that by incorporating trees with arable crops, biomass production per unit area could be increased substantially when the roots of trees exploit water and nutrients below the shallow roots of crops and when a mixed canopy intercepts more solar energy.

Saka *et al*., (1990) stated that an agroforestry system can provide a sound ecological basis for increased crop and animal productivities, more dependable economic returns and greater diversities in social benefits on a sustained basis.

Bhatia and Singh (1994) observed that agroforestry systems in India plays an important role in increasing biomass production, maintaining soil fertility, conserving and improving soil averting risk.

2.2 General introduction of neem

Neem (*Azadirachta indica*), is known as Neem, Nimtree, and Indian Lilacis a tree in the mahogany family Meliaceae. It is one of two species in the genus *Azadirachta*, and is nativeto India and the Indian subcontinent including Nepal, Pakistan, Bangladesh and Sri-Lanka. The latinized name of neem, *Azadirachta indica*, is derived from the Persian. Azad means "free"; dirakht means "tree"; indica-Hind means "of Indian origin". Hence it literally means "the free tree of India" (Neem Foundation, 2012).

Neem is the source of unique natural products including those for integrated pest management, medicine, and industrial purposes. It is well known not only for its medicinal and bioactive properties, but also as a versatile agroforestry species of the semiarid and arid tropics (Koul *et al.,* 1990; Ketkar and Ketkar, 1995). The report by the US National Academy of Sciences (1992) stated neem trees show desirable properties for assisting with global environmental concerns.

Neem is native of dry areas of the Indian subcontinent, Myanmar and China (Rojas-Sandoval *et al.,* 2014). It was naturally distributed in Thailand, Malaysia and Indonesia and has become one of the most widespread trees in tropical and subtropical areas. It has become invasive in the Caribbean (Puerto Rico, Dominican Republic), sub-Saharan Africa (Kenya, Gambia, Senegal, Guinea Bissau, Ghana, Tanzania), and the Pacific (Australia, Fiji, Marshall Islands) (Rojas-Sandoval *et al.,* 2014).

Neem naturally occurs in dry deciduous and thorn forests, or acacia forests. In its exotic range, it has become invasive in a number of habitats including fallow agricultural land, savannah, and dry arid forests (coastal forest in Ghana, lowland monsoon forest in Indonesia, evergreen and dry deciduous forest in Africa) (Orwa *et al.,* 2009). Neem can be found from sea level up to an altitude of 1500 m in places where average annual rainfall ranges from 400 to 1200 mm and where average annual maximum temperatures may be as high as 40°C. Adult trees tolerate some frost but seedlings are sensitive to it. Neem can grow on a wide range of soils, from acidic to alkaline pH, but it does better on shallow, stony, sandy, poor soils, in marginal sloping places or on rocky crevices (Puri, 1999). Neem is a full sunlight species but it can withstand some shade in its first years (Orwa *et al.,* 2009). Neem is able to extract nutrients from highly leached sandy soils and can survive extreme pH conditions, from 3 to 9 (Rojas-Sandoval *et al.,* 2014). In well-drained soils, neem withstands up to 2500 mm rainfall. Neem has some tolerance of salinity and has been used in sugarcane plantations with significant soil salinity (Orwa *et al.,* 2009; Ahmed *et al.,* 1997).

Neem is a medium-sized tree, reaching 15 to 30 m in height, with a large rounded crown up to 10-20 m in diameter. It is mainly evergreen but sometimes shed its leaves during the dry season (Orwa *et al.,* 2009; Puri, 1999). Neem has a deep taproot and is a mycorrhizal-dependent species. The bark is grey, becomes fissured and flakes in old trees. A sticky foetid sap exudates from old trees in humid climates. The branches are numerous and spreading. The leaves are alternate, petiolated, clustered at the end of the branches, unequally pinnate, glabrous and dark glossy green at maturity, 20-40 cm in length and bearing 10-20 leaflets (FAO, 2015). The leaflets are 5-10 cm long x 1.2-4 cm broad, sickle-shaped and slightly denticulate (FAO, 2015). Neem flowers are borne in narrow, branched clusters (panicles) 5 to 15 cm long. Individual flowers are composed of 5 light-green, rounded calyx lobes; 5 white, oblong, rounded petals 0.5 cm long; 10 stamens united in a tube; and a pistil with a rounded ovary and slender style. In its native range and in the Caribbean, neem flowers between March and May (Brandis, 1971). In the Sudan-Sahelian zone of Africa, flowering generally occurs between April and July (Anon, 1988). The olive-shaped fruits (drupes) are 1.0 to 2.0 cm long, smooth, and greenish yellow to yellow when mature. Neem fruits ripen from June to August in India and between September and December in the Sudan-Sahelian zone of Africa (Anon, 1988; Brandis, 1971; Troup, 1981). Fruits usually contain a single elliptic seed, occasionally two, surrounded by a sweet pulp, which has strong garlic like odor. Fruit production usually begins when trees are 3 to 5 years old and is profuse when trees become fully productive at approximately age 10 (Ahmed and Grainge, 1986; Streets, 1962). There are normally between 4,000 to 5,000 seeds per kilogram found in neem fruits, although published data on seed weights range from 900 to 6,300 seeds per kilogram (Anon, 1988; Chaturvedi, 1985). Seeds are dispersed by birds. The fruits should be collected from branches when fully ripe or from the ground within 1 to 2 days after fruit fall. The fruits are then spread on mats under light shade and air dried for 4 to

5 days (Smith, 1939). After drying, they may be stored at ambient temperature in cloth sacks before sowing.

Neem is a multipurpose tree. People consume its fruits raw or cooked, and sometimes eat the young twigs and flowers as vegetables (Orwa *et al.,* 2009). Neem leaves, bark and seed extracts have been used for centuries in India in ethnomedicine and ethnoveterinary medicine (Biswas *et al.,* 2002; Subapriya *et al.,* 2005). The seeds are an important source of azadirachtin, a limonoid compound (triterpenoid) present in the seeds, and also to some extent in leaves and other tissues. It acts as an insect repellent, inhibiting them from feeding, thus disrupting their growth, metamorphosis and reproduction (Orwa *et al.,* 2009). Extracts or crude parts of the tree are often mixed with stored seeds such as maize, rice and beans, in order to protect them against insects (Boeke *et al.,* 2004). In India, neem-based pesticides have been developed (Orwa *et al.,* 2009). Neem extracts can protect plants from foliage-eating insects without affecting pollinating insects such as honeybees. Other neem limonoids have various properties. Melantriol and salannin act as antifeedants for insects. Nimbin and nimbindin (the latter a bitter compound present in the seed at 2%) were reported to have antiviral activity (Bostid, 1992). The oil extracted from the seeds has industrial uses and is widely used in ethnomedicine in India. The use of neem products for animal feeding remains limited. While neem leaves can be an occasional forage for ruminants and rabbits, neem seed oil cake, resulting from oil extraction of whole seeds (neem seed cake), or decorticated seeds (neem seed kernel cake), is usually considered as a non-edible oil cake only to be used as organic nitrogenous fertilizer (Ramachandran *et al.,* 2007).

Neem is suitable for dune fixation and for soil reclamation in areas where salinity occurs. Neem seed cake is used as an organic manure that improves the efficiency of added N fertilizer as it delays the nitrification of soil. Neem leaves and small twigs can be used as mulch. In Burkina Faso, mulch made with neem leaves increased the yield of sorghum grain by 0.5 t/ha/year (Orwa *et al.,* 2009; Tilander *et al.,* 1997). Neem products reduce insect growth in crops and plants. Thus, neem products can be used as neem insecticide, neem pesticide, neem fumigant, neem fertilizer, neem manure, neem compost, neem urea coating agent and neem soil conditioner (Hossain *et al.,* 2008). Neem is a valuable shade tree that is particularly appreciated in India where it is planted on avenues, along roads and in villages (Orwa *et al.,* 2009). It provides a good windbreak (Ahmed *et al.,* 1997). In Haiti, it has been suggested to use neem for afforestation (Bostid, 1992).

Neem tree is described as drought tolerant with no specific site requirement (Elteraifi *et al.,* 2001). Thus it is suitable for the improvement of degraded lands and therefore, considered important in desertification control and reforestation programs in some countries of the world. The large scale plantation of neem trees help to combat desertification, deforestation, soil erosion and to reduce excessive global warming (Sateesh, 1998). Neem has high rate of photosynthesis and liberates more oxygen than many other tree species, thus purifying the atmosphere (Nigam *et al.,* 1994). Neem products have water purifying activity. Neem leaf powder could be used as bio-sorbent for the removal of dyes like Congo red from water (Bhattacharyya and Sharma, 2004). The temperature under the neem has been found to be 10°C less than the surrounding temperature, during hot summer months in the northern parts of India. In agro-forestry, neem product benefits extended to providing shade, firewood, timber, wind breaks, shelter belt and check against desertification in the semi-arid zone of northern Nigeria (Nwokeabia, 1994).

2.3 Concept of Composts

Compost is organic matter that has been decomposed and recycled as a fertilizer and soil amendment. Compost is a key ingredient in organic farming (Nyoni, 2007).

Devendra and Thomas (2002) indicated that At the simplest level, the process of composting requires making a heap of wet organic matter known as green waste (leaves, food waste) and waiting for the materials to break down into humus after a period of weeks or months. Modern, methodical composting is a multi-step, closely monitored process with measured inputs of water, air, and carbon- and nitrogen-rich materials. The decomposition process is aided by shredding the plant matter, adding water and ensuring proper aeration by regularly turning the mixture. Worms and fungi further break up the material. Bacteria requiring oxygen to function (aerobic bacteria) and fungi manage the chemical process by converting the inputs into heat, carbon dioxide and ammonium. The ammonium (NH_4^+) is the form of nitrogen used by plants. When available ammonium is not used by plants it is further converted by bacteria into nitrates (NO_3^-) through the process of nitrification.

According to Darby *et al.* (2006) Compost is rich in nutrients. It is used in gardens, landscaping, horticulture, and agriculture. The compost itself is beneficial for the land in many ways, including as a soil conditioner, a fertilizer, addition of vital humus or humic acids, and as a natural pesticide for soil. In ecosystems, compost is useful for erosion control, land and stream reclamation, wetland construction, and as landfill cover (see compost uses). Organic ingredients intended for composting can alternatively be used to generate biogas through anaerobic digestion.

2.4 Importance of different type of composts

Kitchen waste

Kitchen waste is defined as left-over organic matter from restaurants, hotels and households (Subler *et al.,* 1998). Tons of kitchen wastes are produced daily in highly populated areas. Kitchen wastes entering the mixed-municipal waste system are difficult to process by standard means, such as incineration, due to the high moisture content. Furthermore, organic matter can be transformed into useful fertilizer and biofuel (Lee, *et al.,* 1976). New disposal methods that are both environmentally and economically efficient are being developed which rely on various forms of microbial decomposition.

Kitchen waste is a nutrient rich, or eutrophic, environment containing high levels of carbohydrates, lipids, proteins, and other organic molecules which can support abundant populations of microorganisms (Wang, *et al*., 2001). The anaerobic nature of kitchen wastes is typical for a eutrophic environment, because aerobic bacteria deplete oxygen through respiration at a faster rate than oxygen can be replenished by diffusion. Although the presence of water is essential for bacteria growth, the high moisture content in kitchen waste exacerbates the anaerobic condition as oxygen is insoluble in water and it is hard for oxygen to diffuse through water (Wang, *et al*., 2002). Kitchen waste is usually acidic due to the action of acid fermentation bacteria such as lactic acid bacteria (Subler, *et al.,* 1998). As lactic acid can act as an uncoupler in acidic environment, it is toxic to other bacteria, thus a buffer is usually added into kitchen wastes to make the environment less acidic. Overall, the high moisture and nutrient level make kitchen waste an ideal environment for anaerobic biodegradation.

Cow dung

Lulandala (2011) and Krishnal (2012) reported that Fertilization is a tried-and-true way to get ornamental and edible plants to grow, flower and fruit at their optimum levels. Manure is one of the oldest methods of fertilization, and using cow manure in a home garden is actually fairly simple. Its other advantages include high nutrient levels and widespread availability, but take precautions when using it.

According to De Araujo *et al*. (2009) Cow manure contains the three main plant nutrients: nitrogen, phosphorus and potassium. Although some natural variation occurs among manure from different cows, the amounts in fresh cow manure with bedding or litter are roughly 11 percent nitrogen, 4 percent phosphorus and 10 percent potassium, and the nutrients become available to plants at a moderate speed. Fresh cow manure with bedding or litter also has a sizable water content -- 86 percent; therefore, it is beneficial because it helps to keep soil evenly moist throughout the growing season.

Adding to cow manure's benefits is the fact that it is not difficult to find. Many dairy farmers offer free manure to people who haul it away. Even where payment is expected, it is generally no more than a small fee for enough to fill a truck's bed. Check before getting cow manure, however, because a big difference exists between fresh manure and aged manure, both of which are widely available. Both are fine to use, but they need to be treated and used differently (Bertoldia *et al.,* 1983).

Poultry manure

Njuki (2001) reported that Poultry manure is often sold in dried and pelleted form by garden centres and is a good non-chemical fertilizer. Dried, pelleted and powdered forms are distinct from fresh domestic poultry litter, which is best used on the compost heap.

According to Barral *et al*. (2009) Poultry manure products are one of the most commonly available non-chemical fertilizers on the market. Poultry manure is a useful source of nitrogen, the main nutrient that plants need for green leafy growth. It also contains smaller amounts of other important nutrients. However, poultry manure is low in nutrients compared to synthetic fertilizers such as Growmore, as illustrated below, and it is slower to release its nutrient content, some of which will not be available until the soil warms up in late spring and summer, even if the product is applied in late winter or early spring.

According to Farrell and Jones (2009) Fresh manure from commercial poultry operations is rarely available to home gardeners, as it is unpleasant to transport and use. If you are able to access a source, then it can be used as a spring top dressing for crops requiring plenty of nitrogen, such as blackcurrants, vegetables and plum trees. It can also be put on the compost heap, adding a 5cm (2in) layer to every 15cm (6in) of other material. Fresh and composted poultry litter may contain bacteria that are harmful to humans. Avoid breathing in the dust of these products, wear gloves when handling them, and avoid eating and smoking while working with them. Avoid using poultry litter during confirmed or suspected outbreaks of bird 'flu if you are in an affected area.

According to Bernal *et al.* (2009) Dried and processed poultry manure products, such as pellets and powders, are often sterilised during manufacture, so are less of a risk. Dried poultry manure can be used on vegetable and fruit crops, although additional potassium fertilizer may be needed (e.g. sulphate of potash or organic potassium-rich fertilizers derived from sugar beet processing)

Sawdust

According to Kawasaki *et al.* (2008) Sawdust or wood dust is a by-product of cutting, grinding, drilling, sanding, or otherwise pulverizing wood or any other material with a saw or other tool; it is composed of fine particles of wood. It is also the byproduct of certain animals, birds and insects which live in wood, such as the woodpecker and carpenter ant. It can present a hazard in manufacturing industries, especially in terms of its flammability. Sawdust is the main component of particleboard.

According to Gao *et al.* (2010) A major use of sawdust is for particleboard; coarse sawdust may be used for wood pulp. Sawdust has a variety of other practical uses, including serving as a mulch, as an alternative to clay cat litter, or as a fuel. Until the advent of refrigeration, it was often used in icehouses to keep ice frozen during the summer. It has been used in artistic displays, and as scatter in miniature railroad and other models. It is also sometimes used to soak up liquid spills, allowing the spill to be easily collected or swept aside. As such, it was formerly common on barroom floors.[1] It is used to make Cutler's resin. Mixed with water and frozen, it forms pykrete, a slow-melting, much stronger form of ice.

Sawdust is used in the manufacture of charcoal briquettes. The claim for invention of the first commercial charcoal briquettes goes to Henry Ford who created them from the wood scraps and sawdust produced by his automobile factory (Green, Harvay wood, 2006).

Ash

According to Demaere *et al.* (2008) Composting ashes is an ideal way to put them to use in the garden. Fireplace ashes for compost can be used to help maintain the neutral condition of the compost. It can also add nutrients to the soil. Decomposing materials in the compost pile can become somewhat acidic and wood ash can help offset this, as it's more alkaline in nature. However, it may not be a good idea to use charcoal ashes, such as those from grills. Compost with charcoal can have chemical residue from the additives in the charcoal. These chemicals can be harmful to plants, especially when used in large amounts. Therefore, it is better to stick with wood ash—provided that the wood used has not been treated or painted.

2.5 Effect of compost on soil

According to Bertoldi *et al.* (1983) and Bernal *et al.* (2009) compost have several advantages compare to plant residues when applied to soils such as reduce volume, slower mineralization rates and recycling of municipal biosolid wastes. Compost has two main effects on soils particularly nutrient, poor soils; replenish soil organic matter and supply plant nutrients (Sanchez-Mondero *et al.*, 2004; Tejada *et al.*, 2009b).organic matter plays a crucial role in improving physical, chemical and biological properties of soils. Soil structure can be improve by the binding between soil organic matter and clay particles via cation bridges and through stimulation of microbial activity and root growth (Farrell and Joness, 2009; Gao *et al.*, 2010). According to Tisdal and Oades (1982), Organic matter can indirectly improve soil structure by increasing microbial activity and thus production of microbial slimes, fungal hyphe and/ or roots bind aggregates together Organic matter is a significant reservoir of nutrients in a plant available form (Baldock, 2007).

Other benificial effects of compost include increasing water holding capacity and plant water availability (CIWMB, 2004; Curtis and Classen,2005; Farrell and Jones, 2009), decreasing leaching of nutrients (Gale *et al.,* 2006; Hepperly *et al*., 2009), reducing erosion and evaporation and prevention of plant diseases (Gershuny,1994).Further ,compost can act as a long-term slow release fertilizer. However, the application of compost can have negative effects on plant growth due to its unpleasant or nuisance odour production, potential to inhibit plant growth and reduce N availability in the soil. The beneficial effects of compost are only achieved when organic mater is added to soil.

2.6 Effects of compost on plant growth and nutrient uptake

Applying compost to soils can increase plant nutrient availability (Epstein, 1997; Heymann *et al*., 2005; Kawasaki *et al*., 2008). Compared to the same amount of N and P added, plant N and P uptake from compost may be lower than that from inorganic N fertilizer, because the organic N in the kitchen waste has to be mineralised before it can be taken up by plants or because of microbial immobilisation of N (Ebid, 2008; Odlare and pell, 2009; Vance *et al*., 1987). However, initial slow minoeralisation can sustain the release of N for the following seasons; over a 2 year period, 36-44% of compost N was mineralised (Passoni and Bonn, 2009).Compost from fruit residues, manure, and kitchen waste can also increase the retention of applied fertilizer N in the soil-plant system by stimulation of plant N uptake and microbial immobilization and reduced N leaching and gaseous losses (Steiner *et al*., 2008; Vance *et al*., 1987).

A study of Curtis and claassen (2005) showed that incorporation of compost (24%v/v) from yarr resulted in greater than a 2 fold increase in plant- water availability and increased the ability of the plants to access this water resource through greater root proliferation.

Compost can stimulate plant growth, root development and thus nutrient uptake (Lopez-Bucio *et al*., 2003; Oworu *et al*., 2010; Soumare *et al*., 2003; Walker and Bernal, 2008). Humic substances, the major component of soil organic matter in compost can increase in shoot biomass via hormonal effect on root elongation and plant development (Atiyeh *et al*., 2002; Lazcano *et al*., 2002; Zandondi *et al*., 2007).

To summarize, compost addition can increase soil nutrient availability and thereby nutrient uptake by plants. This effect can be direct or indirect. Direct effects are via nutrients added the compost whereas indirect effects are via increased microbial activity can increase nutrient mobilization but may also result in immobilization of nutrients. The improved soil structure and water retention will promote root growth and thus the soil volume accessed by the plant.

2.7 Important of *Melia azedarach*

Albuquerque *et al.*, (2010) observed that the phenomenon of allelopathy has recently received greater attention from researchers and farmers worldwide crop failures and low yields caused by the reseeding, over seeding, crop rotation and replanting of fruit trees in orchards are believed to be caused by allelopathic activity. Moreover, the expensive and environmentally impacting herbicides for weed control have motivated studies directed at developing cheaper, environmentally-friendly alternatives. The release and dynamics of allelochemicals in the soil are discussed herein. Examples of allelopathic crops, the allelochemicals produced and their uses in cropping systems are also presented along with current research trends regarding allelopathy.

The efficacy of aqueous extracts of twenty plants was observed by Bhardwaj and Laura in 2009 for their antifungal activity against *Chaetomium globosum*, causal organism of decay of cotton and other cellulose materials. The maximum inhibitory effect was shown by stem extracts of Aloevera (85.72%), while leaf extracts of *Camellia sinensis* (79.69%), bark extracts of *Acacia arabicae* (79.06%) and bark extracts of *Callistemon lanceolatus* (58.34%) showed strong inhibitory effect. Some of the other plants showed moderate inhibition against the mycelium growth of test fungi i.e. *Azadirachta indica* > *Albizia lebbeck* > *Aegle marmelos* > *Acacia catechu*.

Al-Charchafchi *et al.* (2007) found that germination percentage and seedling growth of *Vigna radiata* significantly decreased gradually as the concentration of the aqueous leaves extracts of *Azadirachta indica* increased in comparison with water control. Severe toxicity was observed at high concentrations and moderate toxicity at low concentrations in comparison with water control. Aqueous leaves extract significantly inhibited root length more than shoot. These results indicated that some kind of inhibitor(s) was the responsible agent for the phytotoxic effect of *A. indica* on germination and seedling growth of *V. radiata*.

Although *Azadirachta indica*, the so-called Neem or Nim, is well-known for its biological activities in many countries, the inhibitory effects of this extract on *Phaseolus vulgaris* germination and growth were also evaluated, indicating that both seed germination and radicle growth were affected in a concentration- dependent manner. It was studied by Silva *et al*. (2007).

The effect of 2, 4 and 8% (w/v) aqueous extracts of dry leaves of *Alstonia scholaris* (L.), *Azadirachta indica* (L.). *Eucalyptus citriodora*, *Mangifera indica* L. and *Syzygium cumini* (L.) Skeels against germination and seedling growth of one of the most serious weeds of wheat viz. *Phalaris minor* was observed by Arshad-Javaid *et al*. in 2006. Aqueous extracts of all the employed concentrations of *A. scholaris*, *A. indica* and *E. citiodora* proved highly effective resulting in significant reduction of 43-100% in final germination of the target weed species. Aqueous extracts of *M. indica* and *S. cumini* proved less effective where only highest concentration of 8% exhibited significant negative impact against the germination of *P. minor*. Generally, not always, the higher concentrations of 4 and 8% significantly reduced the seedling root and shoot growth of the target weed species.

Rathinasabapathi *et al*., (2005) reported that eluates of wood chips from red maple (*Acer rubrum* L.), swamp chestnut oak (*Quercus michauxii Nutt*.), red cedar (*Juniperus silicicola* L. *H. Bailey*), neem (*Azadirachta indica A. Juss*.), and magnolia (*Magnolia grandiflora* L.) highly inhibited germinating lettuce seeds, as assessed by inhibition of hypocotyl and radicle growth. The effects of wood chip eluates from these five species were more than that found for eluates from wood chips of black walnut (*Juglans nigra* L.,) a species previously identified to have weed-suppressing allelochemicals. Tests on red cedar, red maple, and neem showed that water-soluble allelochemicals were present not only in the wood but also in the leaves. In greenhouse trials, red cedar wood chip mulch significantly inhibited the growth of florida beggar weed (*Desmodium tortuosum* DC.), compared to the gravel- mulched and no-mulch controls.

Although the neem (*Azadirachta indica*) tree has been known to be useful in soil enrichment and for insect, pest and disease Control was reported by Tran-Dang- Xuan *et al*., 2004. Its allelopathic potential strongly inhibits germination and growth of several specific crops: alfalfa (*Medicago sativa* L.), bean (*Vigna angularis*), carrot (*Daucus carota* L.), radish (*Raphanus sativus* L.), rice (*Oryza sativa* L.), and sesame (*Sesamum* *indicum* L.) and weeds: *Echinochloa crus-galli*, *Monochoria vaginalis*, and *Aeschynomene indica* L. in a bioassay and in soil. The sensitivity of weeds varied between bioassay and soil. In all culture conditions, inhibition from neem bark was greater than from leaves. Six phenolic compounds including gallic acid, benzoic acid, p-coumaric acid, p-hydroxybenzoic acid, Vanillic acid, and trans-cinamic acid were isolated and identified in both neem bark and leaves. Ferulic acid was found in the bark. Concentration of these phenolic compounds in bark was higher than in the leaves.

Hong *et al*., (2004) reported that *Datura stramonium* L., *Desmodium triflorum* L and *Melia azedarach* L. exhibited similar inhibitory magnitude at 1 t ha^{-1} achieving more than 90% weed control. *Clerodendrum trichotomum* L. achieved about 70% weed reduction at 2 t ha^{-1}. In paddy fields, *D. triflorum* was the most promising material for weed control and attained the highest rice yield among treatments, at the concentration of 2 t ha^{-1}, whereas the inhibition of *D. stramonium* and *M. azedarach* was weakened. No injury of rice plants was observed. These plants might be used as natural herbicides to reduce the dependence on synthetic herbicides.

But Amit- Walia and Bisla (2003) observed that the germination and seedling growth parameters of radish decreased significantly over the control at all concentrations (5, 10 and 15%) of neem leaf extract all. Significant inhibition in germination parameters and root length of onion was observed while shoot length and dry weight per seedling exhibited no significant changes. The magnitude of reduction in germination was more prominent in onion than in radish and the reverse was observed for seedling growth.

Nguyen *et al*. (2003) stated that the greatest allelopathic potential were *Galactia pendula*, *Leucaena glauca* and *Melia azedarach*. Four other species including *Desmodium rezoni*, *Eqphobia hirta*, *Manihot esculenta* and, *Morus alba* were assessed to be the second most suppressive to radish germination and growth. Findings also indicated inhibitory exhibition of allelopathic plants were species dependent. Moreover, inhibitory effects varied among plant parts such as the leaves, stem and root.

Azadirachta indica reduced the germination, shoot length, root length, dry matter, and number of leaves and grain yield of cowpea, sesame, horse gram and sorghum. Maximum reduction in shoot and root length was recorded under rhizosphere soil. Maximum reduction in dry matter production and maximum suppression of grain yield was observed in the soil mulched with crushed dry leaves. Among the four test crops, cowpea was least affected in terms of growth and yield compared to the other test crops. It is recommended that cowpea could be an ideal crop component for *A. indica* under rainfed conditions (Divya and Yassin, 2003).

Channal *et al*. (2002) Studies on the allelopathic effect of seven tree leaf extracts, viz. *Syzygium cumini*, *Acacia arabica* [*Acacia nilotica*], *Tectona grandis*, *Eucalyptus tereticornis*, *Tamarindus indica*, *Samanea saman* and A*zadirachta indica* each at 5 and 10% concentration on sunflower and soybean indicated that germination of sunflower was increased by *Tectona grandis*, *Tamarindus indica* and *Samanea saman* each at 5 and 10% concentration, while it was suppressed by *E. tereticornis* and *Acacia arabica*. Soybean germination was increased by *Acacia arabica*, *Tectona grandis*, *Samanea saman* and *Azadirachta indica* at both concentrations, while it was decreased by *Tamarindus indica*. Similarly, seedling length, vigour index and seedling dry matter was also influenced by tree leaf extracts at different concentrations. The seedling length of sunflower was significantly increased by *Syzygium cumini*, *Azadirachta indica*, *Acacia Arabica* and *Samanea saman*, while that of soybean was increased by all tree leaf extracts, though the effect was not that significant compared to sunflower. Almost all the leaf extracts enhanced vigour index in sunflower, while only *Tectona grandis*, *Acacia arabica* and *Azadirachta indica* increased the vigour index in soybean. The seedling dry matter was markedly decreased by *Acacia arabica*, *E. tereticornis*, *Tamarindus indica* and *Azadirachta indica* in sunflower, while all leaf extracts except *E. tereticornis* decreased the seedling dry matter of soybean.

An experiment was studied by Amit-Walia *et al*. (2002a) found that seed germination, seedling growth, and root and shoot length of radish and onions significantly decreased with increasing concentrations of neem leaf leachate, with onion recording higher reductions in the values of the parameters measured, indicating that radishes are more tolerant of the allelochemicals than onions. Reductions in the dry weight of seedlings were significant for radishes and non-significant for onions.

Amit-Walia *et al*. (2002b) performed a study to characterize the allelopathic effect of different concentrations (5, 10, and 15%) of neem (*Azadirachta indica*) leaf leachate and extract on germination and early seedling growth of rabi crops, namely wheat and barley. The germination and early seedling growth of both test crops were reduced significantly over control at all the concentrations of leachate and extract. The inhibitory effect of leachate and extract was found more on barley in comparison of wheat and concentration dependent on both test crops.

A pot study was investigated by using field soil amended with 5 g/kg oilseed cakes of *Azadirachta indica* (neem), *Madhuca indica* [*Madhuca longifolia*] (mahua) and *Gossypium indicum* [*Gossypium sp*.] (Cotton). The soil around the root zone was sampled to study the rhizosphere mycoflora of *A. lebbeck* 30, 60 and 90 days after sowing. A total of 24 fungal species (saprophytic and parasitic) were isolated from the soil. Soil amended with mahua oilseed cake had the highest rate of reduced fungal frequency followed by cotton and neem seed cake (Yasmeen and Shamim, 2000).

Channal *et al*. (2000) conducted a study to evaluate the allelopathic effect of leaf extracts from *Azadirachta indica*, *Acacia arabica* [*Acacia nilotica*], *Eucalyptus tereticornis*, *Tamarindus indica*, *Tectona grandis*, *Samanea Saman* and *Syzygium cumini*, all applied 5 and 10% concentration, on seed germination, vigour index, seedling length, and seedling dry matter of sorghum and rice. Irrespective of concentration, all tree leaf extracts promoted germination in sorghum (15-32% over the control), while only *Azadirachta indica* and *Acacia arabica* increased germination in rice (3.50-3.81% over the control). Seedling length was considerably decreased in sorghum due to *Syzygium cumini*, *Tectona grandis* and *E. tereticornis* and in rice due to *E. tereticornis* and *Tamarindus indica*. Seedling length was markedly increased in sorghum due to *Acacia arabica* and in rice due to *Azadirachta inclica*, *Samanea saman* and *Acacia arabica*. Leaf extracts from *Acacia arabica*, *Samanea saman* and *Azadirachta indica* at 5 and 10% enhanced vigour index in sorghum, while *Acacia arabica* and *samanea soman* at either concentration increased vigour index in rice. Vigour index was markedly decreased in sorghum due to *Eucalyptus tereticorms* and *Syzygium cumini* and in rice due to *Syzygium cumini*, *Tamarindus grandis* and *Eucatyptus tereticornis*. Leaf extracts decreased the seedling dry matter in sorghum and rice irrespective of concentrations.

2.8 Uses of Neem

Sattar *et al*. (1992) studied on the physical, mechanical and seasoning properties of ten village tree species including ghora neem (*Melia azadarach*). They found that ghora neem is a light and weak timber species but can be used for furniture and other purposes like house posts, beams, agricultural implements, and heavy furniture and construction purposes. This species can be seasoned with care within 5 to 8 days.

Wu *et al.* (2009) studied on the isolation of three new [(20*S*)-5, 24(28)-ergostadiene-3β, 7α, 16β, 20-tetrol (1), (20*S*)-5-ergostene-3β, 7α, 16β, 20-tetrol (2), and 2α, 3β-dihydro-5-pregnen-16-one (3)] and several known (4–6) steroids from the leaves of Chinese *Melia azedarach.* The cytotoxicities of the isolated compounds against three human cancer cell lines (A549, H460, U251) were evaluated; only compounds 1**,** 2, and (20*S*)-5-stigmastene-3β,7α,20-triol (4) were found to show significant cyctotoxic effects with IC_{50}s from 12.0 to 30.1 μg/mL.

Oelrichs *et al.* (1983) isolated four new tetranortriterpenes, meliatoxins A_1, A_2, B_1 and B_2 and these have been identified as toxic constituents of the fruit of *Melia azedarach* L. var. *australasica*. According to their results its toxicity and pathogenicity, the meliatoxins are responsible for most but not all of the symptoms resulting from the ingestion of whole fruit.

Nathan *et al.* (2006) observed that Methanolic extracts of leaves and seeds from the chinaberry tree, *Melia azedarach* L. (Meliaceae) showed strong larvicidal, pupicidal, adulticidal, antiovipositional activity against repellency and biting deterrency of mature and immature mosquito vector *Anopheles stephensi* Liston (Diptera) under laboratory condition. They estimated that the *M. azedarach* seed and leaf extracts were used to determine their effect on *A. stephensi* adults and their corresponding oviposition and consequent adult emergence in comparison with the control and also found that the seed extracts showed high bioactivity at all doses, while the leaf extracts proved to be active, only in the higher dose. They established clear dose–response relationships with the highest dose of 2% plant extract evoking 96% mortality and that's why the entire development of *A. stephensi* was inhibited by *M. azedarach* treatment. They also said that less expensive (less than US$0. 50 per 1 kg seed), naturally accruing biopesticide could be an alternative for chemical pesticides.

Rahman *et al.* (2014) studied on ghora neem (*Melia azedarach*) plywood for assessing it as an alternative raw material for plywood industries and the important physical and mechanical properties were examined for assessing its quality. The results of physical and mechanical properties of ghora neem plywood were compared with the data obtained with existing market available plywood manufactured with shimul (*Bombax ceiba*). The density of ghora neem plywood and shimul plywood was 541.00 and 499.80 kg/m^3 respectively. The MOR was 58.33 N/mm^2 for ghora neem plywood while it was

32.52 N/mm^2 for the shimul plywood. The MOE was found for ghora neem plywood 3950.01 N/mm^2 and on the other hand, the shimul plywood showed 3224.15 N/mm^2. The ghora neem (*Melia azedarach* L) plywood showed better performance for both physical and mechanical properties and it also follows the standard.

Husain and Anis (2009) determined that an efficient regeneration protocol for rapid multiplication of *Melia azedarach*, an economically as well as medicinally important timber-yielding tree, was developed. Nearly 90% of the culture exhibited axillary bud sprouting and multiple shoot formation from nodal segments derived from 20-year-old candidate plus tree on Murashige and Skoog (MS) medium supplemented with 5 μM 6-benzyladenine (BA). The highest shoot regeneration frequency (92%), maximum number of multiple shoots (19.7 ± 0.31) as well as shoot length (4.9 ± 0.08 cm) was induced from nodal explants on MS medium amended with 5.0 μM BA, 0.5 μM indole-3-acetic acid (IAA) and 30 μM adenine sulfate (AdS). Addition of 250 mg l^{-1} ammonium sulphate, $(NH_4)_2SO_4$, and 100 mg l^{-1} K_2SO_4, prevented defoliation and tip burning without affecting the number of shoots Repeated subculturing of nodal explants on fresh MS medium containing lower concentration of BA (2.5 μM) along with IAA (0.5 μM), AdS (30 μM) and additives was found most suitable growth regulator regime for achieving 1.2-fold increase in shoot multiplication rate. About 90% of the in vitro regenerated shoots were successfully rooted ex vitro by giving a pulse treatment of 250 μM indole-3-butyric acid for 15 min, followed by their transfer to thermocol cups containing soilrite. The raised plantlets were successfully acclimatized first under culture room conditions, then to green house with 85% survival rate.

2.9 Seedling morphological characteristics

There are morphological and physiological characteristics of seedlings. These can be assessed by direct or indirect methods. Morphology is defined as the form or structure of an organism or any of its parts (Thompson, 1985; Haase, 2007). Although morphological assessments do not provide direct information about a seedling's current physiological condition, they can be considered a physical manifestation of a seedling's physiological response to the growing environment (Mexal and Landis, 1990). Many researchers mentioned different morphological attributes (Sutton, 1979; Thompson, 1985). The most common used attributes are height, stem diameter, height: diameter (sturdiness) and shoot: root ratio (Sutton, 1979; Chavasse, 1980; Jaramillo, 1981), shoot weight and root weight. Morphological attributes vary greatly by species, seed zone, and stock type. No single factor has been shown to provide a perfect prediction of out planting success, but each of them has been linked with seedling performance potential in some way (Haase, 2007). The followings are some morphological characteristics which are mentioned briefly.

Shoot height is defined as the distance from the cotyledon scar to the base of the terminal bud on dormant seedlings or to the tip of the shoot on growing seedlings. Stem height is the height of the seedling from the root-collar to the highest terminal bud (Gazal *et al.,* 2004a). Navarro *et al.* (2006) measured seedling height from the top of the root plug to the top of the apical bud.

Because height is correlated to the number of needles on the shoot, it is a good estimate of photosynthetic capacity and transpirational area. This suggests a positive relationship with subsequent growth, but an unpredictable relationship with survival, especially on droughty sites. Sometimes, the relationship between initial height and field performance is inconsistent (Anstey, 1971; Mullin and Svaton, 1972; Pawsey, 1972). Taller seedlings may have a competitive advantage on sites with severe weed competition and may be indicative of superior genetics. Smith (1975) found 11-year height growth of 3+0 Douglas-fir seedlings was highly correlated with initial height. On the other hand, taller seedlings with greater transpirational area may have a disadvantage on dry sites; and exceptionally tall seedlings may be difficult to plant, out of balance (poor shoot-to-root ratio), and subject to wind damage (Ritchie, 1984, Haase, 2007).

Stem diameter (often referred to as root collar diameter or caliper) is defined as the diameter of the main stem of a seedling at or near the cotyledon scar. Gazal *et al.* (2004a) measured stem diameter at 1 cm above the root-collar. Diameter has often been considered the best single predictor of field survival and growth (Thompson, 1985). Of 14 independent nursery seedling characteristics, Omi *et al.* (1986) found that Douglas-fir stem diameter and root weight had the highest correlation with first-year height growth. Blake *et al.* (1989) reported increased survival with increasing stem diameter for Douglas-fir. South *et al.* (1988) examined 30-year growth of loblolly pine (*Pinus taeda* L.) and found average tree volume was highly correlated with seedling diameter at the time of planting. In another study, planting Douglas-fir seedlings 2 mm larger in initial basal diameter resulted in fourth-year stem volume gains of 35% and 43% on two diverse sites (Rose and Ketchum, 2003; Haase, 2007). In general, stem diameter has been found to be a useful predictor of field survival and growth (Mullin and Christ, 1982; Barnett, 1984; Mexal and Landis, 1990).

The number of lateral buds on apical shoots of young red oaks (*Quercus rubra* L.) was found to be highly correlated with shoot length (Ward, 1964). Approximately one-third of these buds subsequently produced branches; the others remained dormant. About 80% of the variation in number of buds and 50% of the variation in number of branches per shoot was accounted for by differences in shoot length. The average number of branches per inch of shoot length was less on longer shoots indicating a reduction in rate of branch formation on fast growing trees. Deliberate injury to terminal portions of a shoot during the dormant season increased the number of branches formed near the residual apex. The branching angle of the first branch formed below the apex of an injured shoot was greater on decapitated shoots than on shoots treated by removing one or more of the buds of the terminal cluster prior to the growing season. The angle of other branches below the apex was not significantly altered by the injurious treatments applied.

The desired morphology of the root is generally less defined than the shoot, although there are differences depending on stock type (bareroot, transplant, and container). These differences center largely on various root form characterizations. Regardless of stock type, research often supports the generalization that seedlings with more roots outperform those with fewer roots, but we have no measures to help us in determining the size of the root volume that may be considered sufficient (Thompson, 1985).

Many researchers reported that number of first-order lateral roots (FOLR) is a promising morphological indicator of stock quality (e.g. Dey and Parker, 1997; Jacobs *et al*., 2005). These roots provide the structural framework of the root system and many sites of new root initiation, and are active in water and nutrient uptake. The number of FOLR is often correlated with out planting growth and survival, and red oak seedlings with 5 or more FOLR have outperformed those with fewer lateral roots (Thompson and Schultz, 1995).

Noland *et al*. (2001) counted all FOLRs that grew from the central root. They studied three species viz. black spruce (*Picea mariana*), jack pine (*Pinus banksiana*) and eastern white pine (*Pinus strobus* L.).

Number of first-order lateral roots (FOLR) that are >1 mm diameter at junction with taproot measured and only those new roots with a length ≥ 0.5 cm were considered (Burdett, 1979).

Jacobs *et al*. (2005) measured number of FOLR which are >1 mm diameter at junction with taproot. They reported that though initial morphological variables in green ash (*Fraxinus pennsylvanika* Marsh) seedlings showed a generally negative relationship between height and growth but number of FOLR tended to show more stable linear relationship with field performance.

Thompson and Schultz (1995) reported that undercutting of hardwood seedlings (black walnut) produced greater number of FOLR but smaller height and diameter in the field condition.

Dey and Parker (1997) studied on the number of FOLR of bareroot undercut red oak (*Quercus rubra* L) seedlings. They reported that initial diameter, shoot length and number of FOLR were positively and significantly correlated with second year height and diameter. These relationships were strongest for diameter. Initial diameter was significantly correlated with root volume, root area and lateral root, taproot and total root dry mass. Weaker relationships existed between initial shoot length and number of FOLR and second-year root system features.

The majority of root morphology studies with deciduous tree species of the eastern USA have focused on FOLR. These studies have shown that hardwood seedlings with >5 FOLR perform better in the field than those with fewer FOLR (Thompson and Schultz, 1995). Also, strong correlations between FOLR and seedling field response suggest that FOLR is one of the best predictors of field performance and competitive ability of out planted seedlings (Dey and Parker, 1997). Though clearly linked to improved plantation establishment, estimate of FOLR likely does not provide the most accurate characterization of root system size. For instance, the FOLR approach generally does not distinguish between small vs. large FOLR. Furthermore, lateral root length and the quantity of higher-order lateral roots (i.e., root fibrosity) are not accounted for. Also, Ponder (2000) showed that although FOLR was positively correlated with 4-year height growth in red oak, it was not useful for predicting field success of black walnut (*Juglans nigra* L.) and white oak (*Quercus alba* L.). Root volume may provide a more accurate quantitative assessment of seedling root system size and quality than the commonly used

FOLR grading criterion, and may better reflect ability of seedling root systems to exploit soil for growth resources.

Fresh weight is the weight of the seedling or its parts on a fresh (operational water content) basis. Dry weight is the weight of the seedling or its parts after drying for a minimum of 48 hours at 68 °C. Weight is commonly measured on whole seedlings or root, shoot, and foliage separately. Because water content in the tissue can vary greatly, dry weight tends to provide a more consistent measurement than fresh weight. Not surprisingly, shoot and root volumes are strongly correlated with shoot and root dry weights. There is a strong relationship between seedling dry weight and stem diameter (Ritchie, 1984); thus it correlates to field survival and growth similarly (Haase, 2007).

The most helpful criterion of the quality of seedlings is the relationship between shoot and root sizes. Size is most conveniently expressed as the ratio of the weight of the shoot to that of the root after the root has been pruned for field planting (May, 1985; Haase, 2007). So, shoot: root is a unit less ratio of seedling balance calculated from shoot and root dry weights. The best quality stock is that which has a relatively small top and a large, fibrous root system. The balance between shoot and roots is of utmost importance to survival of seedlings because a top-heavy seedling has transpiring area out of proportion to the absorbing capacity of the roots (May, 1985).

Generally, quality bareroot seedlings have shoot / root ratio of 3:1 or less and quality container seedlings have shoot / root ratio of 2:1 or less (May, 1985; Haase, 2007). Seedlings with longer stems tend to have an unbalanced shoot-root ratio. Some researchers used shoot to root ratio to find out the differences of biomass allocation of shoot and root among treatments (Royo *et al.,* 2001).

The shoot/root ratio has been used for bareroot stock to provide information about the balance between shoot and root volume, and it may be of substantial value in predicting field performance (Hermann, 1964; Lopushinsky and Beebe, 1976). Seedling weight, finally, often correlates with subsequent field growth, which is probably due to the high correlation with stem diameter (Switzer and Nelson, 1963). Tsakaldimi *et al*. (2009) found that containerized *Quercus ilex* seedlings invested more biomass in shoots than in roots, leading to higher shoot/root ratios (mean=1.5 ±0.06) whereas the naturally regenerated seedlings had shoot/root ratios close to 1.

Seedling quality is defined by many researchers as "fitness for purpose" (e.g. Mattsson, 1997; Lavender *et al.,* 1980), "fitness for the purpose of achieving the objective of management" (Sutton, 1979). May (1985) described it as "fitness for planting in the forest". Ritchie (1984) compared seedling quality with human health stating "there is no one index of human health consequently there is no one yardstick of seedling quality". All are trying to grow high-quality seedlings to perform well in the field. So, it is natural that the seedlings that survive and develop successfully in the field are the good quality seedlings (Mattsson, 1997).

Now, the question is how one can understand the seedling quality before planting in the field. It is important to know because inability to be familiar with seedling quality as a way of planting performance in the field has led to the failure of many reforestation and afforestation projects. Though, using seedling morphology is a quick method to identify the quality of seedlings but only morphological attributes are not enough to find out seedling quality (Grossnickle *et al.,* 1991). Sometimes, these morphological indices could not set together the differences in the seedling physiology (Gazal and Kubiske, 2004). Therefore, the integration of both morphological and physiological characteristics of seedlings is necessary to assess the stock quality as a whole. Reflection of both factors provides a more useful judgment of the fitness of seedlings for field planting (Gazal *et al.,* 2004a).

There are various seedling quality indices developed by the researchers. Some of them are mentioned below:

The most widely used seedling quality index was suggested by Dickson *et al*. (1960). It was used to measure the performance of the seedlings by using seedling morphological traits. The index was designed as follows:

$$\text{Quality index} = \frac{\text{Total Biomass (g)}}{\text{Height (cm)/diameter(mm)} + \text{shoot biomass(g)/root biomass(g)}}$$

Armson and Sadreika (1979) developed an index of seedling quality as follows:

$$\text{Seedling index (S.I.)} = \frac{\text{Height (cm)}}{\text{Root area index (cm)}^2} \times \text{diameter}^2\ (\text{mm}^2)$$

Another seedling index proposed by Wilde *et al.* (1972) that the ratio of the titration-value of roots to the transpiration loss by crowns i. e., $\text{Q.I.} = \frac{\text{Adsorption}}{\text{Transpiration}}$

It is a measure of nursery stock succulence and the relative capacity of the seedling to survive with unfavorable environmental influences of the planting place.

Edgren and Iyer (1979) recommended that volumetric root-top ratios are intimately linked with drought –resistance index values, i.e.

$$\text{Drought} - \text{ Resistance Index } = \frac{\text{Root volume}}{\text{Shootvolume}}$$

Seedling quality index based on mycorrhizal root colonization had also been proposed by Marx (1981) with *Pisolithus tinctorius* (Pt) fungi.

In this index he used the formula, Q.I. $= \frac{a \times b}{c}$

Where,

a = percent of seedlings with any amount of Pt ectomycorrhizae,

b = average percent of feeder roots with Pt ectomycorrhizae, and

c = average percent of total ectomycorrhizal development on seedlings formed by Pt and other fungi.

The Pt index has also been related to field performance (Marx, 1981). Cordell and Marx (1980) showed that mycorrhizae on loblolly pine roots resulted in up to 25% increase in both growth and survival when the seedlings were planted on poor sites. Other studies have also shown improved growth on poor sites due to mycorrhizae association (Marx *et al.,* 1977; Marx and Artman, 1979).

CHAPTER 3

MATERIALS AND METHODS

CHAPTER 3

MATERIALS AND METHODS

In this chapter materials and methods have been presented which include brief description of location of the experimental site, soil, climate, materials used and methods followed in this experiment. The details are described below in the following sub heads:

3.1 Location of the study area

The experimental site was selected in the Research Field of Agroforestry and Environment Research Farm, Hajee Mohammad Danesh Science and Technology University, Dinajpur. The geographical location of the site is between 25° 13' latitude and 88° 23' longitude and about 37.5m above the sea level.

3.2 Selection of compost

Six treatments were selected for the study. These treatments were selected due to their common practice in the farmers' agroforestry fields with the big trees. Beside these, the treatments are locally available.

3.3 Composts collection

All compost i.e. kitchen waste, cowdung, poultry manure, ash, sawdust were collected from local area of HSTU. After collection they were mixed to get compost. These procedures were done at field lab of crop physiology and Ecology (CPE) Dept. of HSTU. By preparing the compost they were mixed with soil the following ratio: compost: soil=1:2

3.4 Container preparation

The experiment was conducted in mud container and placed in the field. The field is situated in a medium high land belonging to the old Himalayan piedmont plain area with well drained and well developed soil. The container soil texture was sandy loam in nature. Container were filled up with the top soil which mixed with different compost.

3.5 Treatment combination

There were seven treatment of compost including control. These compost were applied in the Ghora neem seedlings. The CRD design was followed with four replications in each treatment. These are as follows:

T_1 = kitchen waste + cow dung+ soil

T_2 = kitchen waste + poultry manure + soil

T_3 = kitchen waste + cow dung + poultry manure + soil

T_4 = poultry manure + ash + soil

T_5 = poultry manure + ash + saw dust + soil

T_6=poultry manure + saw dust + soil

T_7=control (only soil)

3.6 Selection of species

Ghora neem is decious tree, multipurpose in agroforestry. This species has been widely planted along the road side, homesteads, railway side etc. Considering the importance and availability, Ghora neem species was selected for this experiment.

3.7 Seed collection

Ghora neem seeds were collected in plus tree ghora neem tree which are available at Hajee Mohammad Danesh Science and Technology University, Dinajpur.

3.8 Pre-sowing treatment

Fruits of Ghora neem were soaked with cold water for 24 hours. Then the fleshy pulps were separated from the seeds. The seeds were then dried in the sun for 1 day. In each treatment, 28 seeds were taken and sown in the germination container where growth medium was different compost mixed with soil. The container were then placed in the open condition of the Agroforestry Research Field of HSTU. After 3 days of seed sowing with seven treatment. Every 2 days water were applied. Everyday I was observed for germination but germination started after 29 days of seed sowing. Then germination data were collected after 29 days of ghora neem seed sowing.

3.9 Germination data

Germination data were collected on the germination percentage, germination speed, shoot number and days of germination initiation etc. Germination speed was calculated as under (Chiapusio *et al*., 1997):

S= (N1*1) + (N2–N1)*1/2 + (N3- N2)*1/3 + … + (Nn- Nn-1) *1/n.

Where, N1, N2, N3, …, Nn-1, Nn refers to the proportion of germinated seeds on the 29th , 30rd , 31^{th,} days, …, n-1, n days.

The inhibitory / stimulatory effects of compost on tested trees were expressed in percentage (%) of control and were calculated according to T/C, where T, is the "treatment" data and C is the "control" data. The effect is stimulatory when the result is greater than 100%, and the effect was inhibitory when the result was less than 100%.

3.10 Data collection

Data were collected on the following parameters- shoot height, no. of branches/leaves, root length (central/tap root length), collar diameter. Data were collected after one month of seed sowing.

3.11 Morphological measurements of plants

The morphology of shoot and roots and their biomass were measured in four times which are: a) initial measurement on 8th January, b) second measurement on 8th February, c) third measurement on 8th march and d) Fourth measurement on 8th April.

3.12 Initial measurements

For initial data, Padilla and Pugnaire (2007) selected 10 seedlings randomly and harvested for every species before transplanting. Prior to transplanting to the field container from the tree base, we took 4 seedlings were randomly selected for the measurement of their above ground and below ground morphology and biomass. Above ground parameters that were measured are seedling height (cm), root collar diameter (mm), length of central roots, number of living branches. Above ground parameters that were measured are shoot dry weight (g) and root dry weight. Total dry biomass was calculated from shoot and root dry weights. The seedling quality index (QI) was calculated using the equation (Dickson *et al.*, 1960): QI=total seedling dry weight (g)/[height (cm)/diameter (mm)+shoot dry weight (g)/root dry weight (g)].

3.13 Root washing of seedling

Each seedling was dug to collect the root systems with minimum damage from the container. To ease the uprooting of seedlings, Zida *et al*. (2008) also used water around the selected seedlings. Then very gently soil, stones, debris, etc. were separated by hand from the root systems under a gentle water flow. All the attached materials are detached from the root systems by following carefully the central root and other tertiary roots by hands. Soil containing roots that could not be separated in the field were processed in the laboratory. In the laboratory, roots and soil were repeatedly submerged in water and finely sieved to retain fine roots. A sieve was used to collect any root fragments detached from the system. After collecting the sampled seedlings with whole root system, they were kept in polythene bags and then stored in a wet place near the field laboratory for further measurements.

3.14 Shoot height measurement

Shoot height is defined as the distance from the cotyledon scar to the base of the terminal bud on dormant seedlings or to the tip of the shoot on growing seedlings. In this experiment, shoot height was measured from the root collar to the base of terminal bud of the living shoot tip (Jacobs *et al.*, 2005; Ritchie, 1984; Haase, 2007) by measuring tape and measuring pole.

3.15 Root collar diameter (RCD) measurement

RCD is considered as the best morphological measurement of seedling quality as reflected in out-planting performance. It is a measure of the seedling's survivability potential and also the parameter on which the seedling quality, price are based on. In this study, RCD was measured by a diameter caliper, 5 mm above the root collar of all the seedlings with an accuracy of 1 and 0.1 mm respectively (Tsakaldimi, 2009).

3.16 Number of branches and Length of central root

Living and non-living branches of the shoot were counted for all the seedlings. Length of central root was measured from the root collar zone to the last part of the taproot.

3.17 First order lateral roots

First-order lateral roots (FOLR $\geq$ 1 mm) that are equal or greater than 1 mm at junction with tap root were counted (Burdett, 1979; Dey and Parker, 1997) and measured. For this, FOLRs were separated carefully by a sharp knife. For measuring lengths and diameters, each FOLR ($\geq$ 1 mm) were numbered serially. Lengths of FOLRs were measured by a measuring tape (made of steel) and diameters of FOLR were measured by a caliper (accuracy 0.1 mm). To measure lengths and diameters, FOLR were separated gently from the central roots by sharp knife and scissor. Diameters of FOLR were taken at the junction of central roots. The FOLRs whose diameters were less than 1 mm were excluded.

After measuring the length and diameter of each FOLR, they were arranged seedling-wise. Then FOLRs of a replication were again sorted and arranged into five different diameter classes such as D_1 (0.1 -0.5 mm), D_2 (>0.5-1.0 mm), D_3 (>1.0-2.0 mm), D_4 (>2.0-3.0 mm), D_5 (>3.0 mm).

3.18 Biomass measurement

For biomass measurement, the seedlings were divided into two parts: shoot and root system. The root systems were separated from the soil through gentle wash of water using a bucket and sieve to collect any root fragments detached from the system. Branches and leaves were mixed together to get the shoot weight. Both parts were oven-dried at 80°C (Royo *et al.,* 2001; Tsakaldimi *et al*., 2005) for 72 hours until they reached in a constant weight. They were weighed through an electric balance to get shoot dry weight (g), root weight (g). Then total oven dry weight (g) was calculated. The root to shoot ratio was calculated by the root and shoot dry weights (Thompson, 1985).

3.19 Seedling Quality Index (QI)

The seedling quality index (QI) was calculated using the equation (Dickson *et al*., 1960): QI=total seedling dry weight (g)/[height (cm)/diameter (mm)+shoot dry weight (g)/root dry weight (g)].

3.20 Statistical Analysis

All statistics were calculated with Statistis 10 software and MS Excel 2010.

CHAPTER 4

RESULTS AND DISCUSSION

CHAPTER 4

RESULTS AND DISCUSSION

The present experiment was carried out to investigate the germination, growth and development root architecture of Ghora neem influenced by different compost. The results of the experiment was shown in tables and figures currently and discussed in this chapter under the following sub-headings.

4.1 Germination

Table 1 and 2 show the number of germination, germinated seeds, cumulative number of germinated shoots and their percentage in different treatments. Germination traits were affected by different compost. Germination was found to start after 29 days of seed sowing (Table 2). After 42 days, highest average number of germinated seeds (11.5) was found in T_4 (Poultry manure + ash) followed by T_3, T_6 and lowest number of germinated seed (2.5) was in kitchen waste + cowdung (Table1).

Corresponding to number of germinated shoots, highest shoot percentage was calculated 383% in T_4 followed by 375 % in T_3, 367 in T_5, 360% in T_2 and lowest shoot percentage was recorded 250 % in T_1 (Table 1).

Table 1: Germination percentage of Ghora neem in different treatments of compost

Treatment*	Total germinated seed out of 4 seed	Number of germinated shoot	Germination %	Shoot %
T_1	1	2.5	25	250
T_2	1.25	4.5	31.25	360
T_3	2	7.5	50	375
T4	3	11.5	75	383
T_5	1.5	5.5	37.5	367
T_6	1.75	6	43.75	343
T_7	1.25	4.25	31.25	340

*T_1=kitchen waste+ cow dung, T_2=kitchen waste+ poultry manure, T_3= kitchen waste + cow dung+ poultry manure, T_4= poultry manure + ash, T_5= poultry manure + saw dust, T_6=poultry manure + ash + sawdust,T_7=onlysoil

Table 2 shows the cumulative germinated shoot of ghora neem where highest germinated shoot was found in T_4 (poultry manure + ash) followed by T_3 (kitchen waste + cow dung + poultry manure), T_6 (poultry manure + ash + saw dust), T_5 (poultry manure + saw dust), T_2 (kitchen waste+ poultry manure), T_7 (control) and the lowest germinated seeds was in kitchen waste + cowdung (T_1) (Table2).

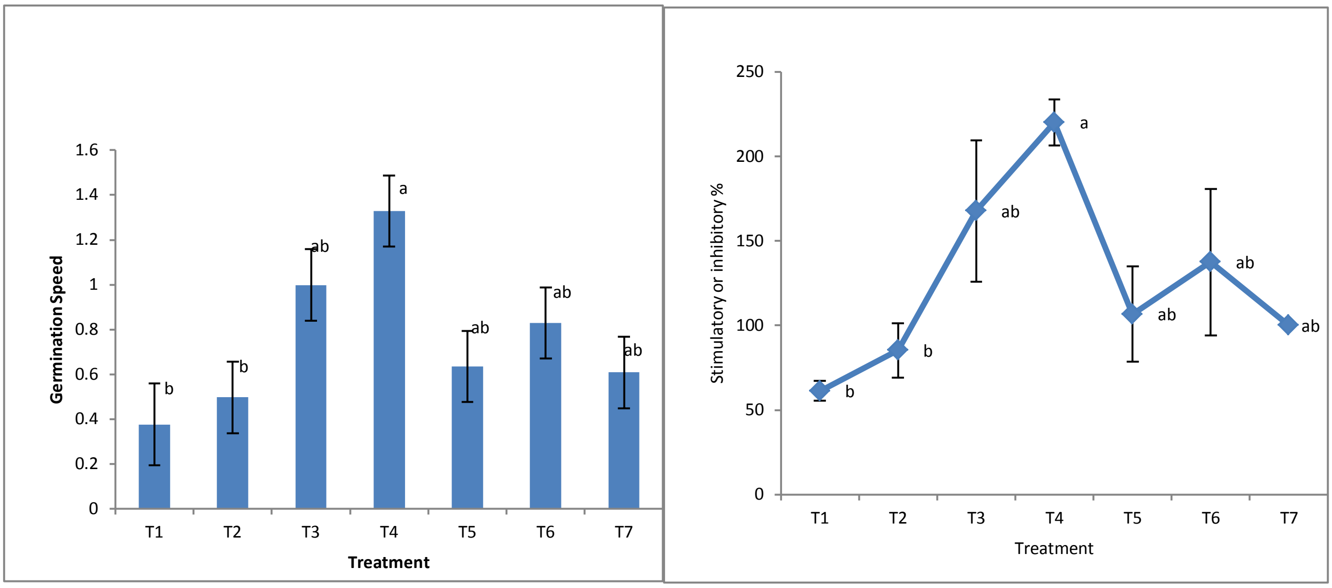
Table 2: Cumulative number of germinated shoot of Ghora neem at different treatments of Compost

Days of germination	Cumulative number of germinated shoot in 4 replications						
	T_1	**T_2**	**T_3**	**T_4**	**T_5**	**T_6**	**T_7**
29	0	0	0	0	0	1	0
30	0	0	0	0	0	1	0
31	0	0	6	6	2	3	4
32	0	0	6	6	2	4	6
33	0	3	9	12	2	4	8
34	4	5	9	14	6	8	8
35	6	7	12	14	10	13	8
36	6	8	19	20	13	13	8
37	6	11	20	22	15	17	8
38	6	11	20	24	16	17	10
39	7	14	24	28	18	18	12
40	19	15	24	34	19	20	12
41	10	18	26	42	20	23	16
42	10	18	30	46	22	24	17

*T_1=kitchen waste+ cow dung, T_2=kitchen waste+ poultry manure, T_3= kitchen waste + cow dung+ poultry manure, T_4= poultry manure + ash, T_5= poultry manure + saw dust, T_6=poultry manure + ash + saw dust, T_7=only soil

4.1.1 Germination speed

Figure 1 showed the germination speed and stimulatory/inhibitory state of Ghora neem seeds due to the effect of the compost. Highest germination speed was found in T_4 (1.33) in poultry manure + ash, followed by T_3 (1.00) kitchen waste + cowdung + poultry manure, T_6 (0.83) poultry manure + ash + sawdust, T_5 (0.64) poultry manure + sawdust, T_7 (0.61) control, T_2 (0.50) kitchen waste + poultry manure and lowest in T_1 (0.38) kitchen waste + cowdung. It might be the stimulatory effect of almost all the compost treatments except T_1 (kitchen waste + cowdung), T_2 (kitchen waste + poultry manure) on the early germination of Ghora neem compared to control (Figure 1b). The maximum stimulatory effect was found in T_4 (poultry manure + ash) and lowest in T_1 (kitchen waste + cowdung). This result shows that all the six treatments have stimulatory effect on the seed germination of Ghora neem than the control.



(a) (b)

Figure 1: Effect of compost on the (a) germination speed and (b) stimulatory/ inhibitory state of Ghora neem. In a bar and line diagram, different letter (s) show statistically significant at P≤0.05 by Tukey‟s Range Test.

Plate 1: Germination of Ghora neem seeds after 1st month in different treatments of compost

4.2 Morphology

4.2.1 Morphology after 1 month

After 1 months, shoot height of Ghora neem (*Melia azedarach*) seedlings was statistically varied differently among the treatments. Shoot height was higher in T_5 (11.90 cm) and lowest in T_2 (5.89 cm). Number of leaves varied differently among the treatments. Highest number of leaves was recorded in T_4 (14.25 cm) and lowest in T_2 (7.00 cm). Collar diameter was higher in T_4 (4.60 cm) and lowest in T_2 (3.00 cm). Length of central root varied significantly among the treatments. The Longest length of central root was found in T_4 and shortest was recorded in other treatments (Table 3).

Table 3: Effect of Compost on the morphological characteristics of shoot and root of *Melia azedarach* seedlings in different treatments after 1 months

Treatment*	Number of leaves	Shoot height (cm)	Root Collar diameter (mm): D	Central root (cm)
T_1	8.5±0.65bc	9.47± 0.36 b	3.65±0.15bc	10.50±0.33d
T_2	7±0.0.41c	5.89±0.36c	3.00±0.09c	13.74±0.23bc
T_3	11±0.41a	9.16±0.20b	4.45±0.19a	11.94±0.32abc
T4	14.25±0.85a	11.62±0.13a	4.60±0.13a	13.10±0.37a
T_5	8.25±0.63bc	11.90±0.45a	3.25±0.13bc	12.96±0.32ab
T_6	11.5±0.65ab	11.69±0.87a	4.9±0.22ab	11.10±0.37cd
T_7	12.75±0.48bc	7.90±0.13b	3.18±0.19bc	11.83±0.39bcd

In a column having similar letter(s) do not differ significantly and figure bearing different letters differ significantly at $P \leq 0.05$ by Tukeys Test.

*T_1=kitchen waste+ cow dung, T_2=kitchen waste+ poultry manure, T_3= kitchen waste + cow dung+ poultry manure, T_4= poultry manure + ash, T_5= poultry manure + saw dust, T_6=poultry manure + ash + saw dust, T_7=only soil

4.2.2 Morphology after 2 months

After 2 months, shoot height of Ghora neem (*Melia azedarach*) seedlings was statistically varied differently among the treatments. Shoot height was higher in T_4 (12.52 cm) and lowest in T_2 (7.55 cm). Number of leaves varied differently among the treatments. Highest number of leaves was recorded in T_4 (16.00 cm) and lowest in T_2

(8.75 cm). Collar diameter was higher in T_4 (4.88 cm) and lowest in T_2 (3.20 cm). Length of central root varied significantly among the treatments. The Longest length of central root was found in T_4 (13.53 cm) and shortest was recorded in other treatments (Table 4).

Table 4: Morphological characteristics of shoot and root of *Melia azedarach* seedlings in different treatments of compost after 2 months

Treatment*	Number of leaves	Shoot length(cm)	Root Collar diameter (mm): D	Central root(cm)
T_1	10.25±0.85cd	10.57±0.22c	3.8±0.04de	10.05±0.27bc
T_2	8.75±0.0.48d	7.55±0.26d	3.2±0.17ab	8.87±1.69c
T_3	12.75±0.48bc	10.43±0.42c	4.63±0.15ab	12.25±0.33ab
T_4	16±0.70a	12.52±0.31ab	4.88±0.06a	13.53±0.34a
T_5	9.75±0.47d	14.18±0.43a	3.53±0.14cd	12.62±0.38ab
T_6	13±0.41bc	11.93±0.80bc	4.08±0.22bc	10.9±0.49abc
T_7	14.75±0.85ab	8.25±0.16d	3.45±0.22cd	11.08±0.39abc

In a column having similar letter(s) do not differ significantly and figure bearing different letters differ significantly at $P \leq 0.05$ by Tukeys Test.

*T_1=kitchen waste+ cow dung, T_2=kitchen waste+ poultry manure, T_3= kitchen waste + cow dung+ poultry manure, T_4= poultry manure + ash, T_5= poultry manure + saw dust, T_6=poultry manure + ash + saw dust, T_7=only soil

4.2.3 Morphology after 3 months

After 3 months, shoot height of Ghora neem (*Melia azedarach*) seedlings was statistically varied differently among the treatments. Shoot height was higher in T_5 (14.63 cm) and lowest in T_2 (7.93 cm). Number of leaves varied differently among the treatments. Highest number of leaves was recorded in T_4 (19.00 cm) and lowest in T_2 (11.00 cm). Collar diameter was higher in T_4 (5.08 cm) and lowest in T_2 (3.40 cm). Length of central root varied significantly among the treatments. The Longest length of central root was found in T_4 (14.10 cm) and shortest was recorded in other treatments (Table 5).

Table 5: Morphological characteristics of shoot and root of *Melia azedarach* seedlings in different treatments of compost after 3 months

Treatment*	Number of leaves	Shoot height (cm)	Root collar diameter (mm): D	Central root(cm)
T_1	13±0.71cd	10.83±0.26c	3.89±0.17bc	10.08±0.34bc
T_2	11±0.41d	7.93±0.30d	3.4±0.09c	9.34±1.78c
T_3	15.25±0.63bc	10.85±0.46c	4.83±0.15a	12.75±0.38bc
T_4	19±0.91a	13±0.23ab	5.08±0.06a	14.1±0.25a
T_5	12±0.41d	14.63±0.43a	3.57±0.16bc	13±0.39ab
T_6	15±0.41bc	12.43±0.81bc	4.4±0.23ab	11.45±0.59abc
T_7	17.25±0.75ab	8.75±0.16d	3.83±0.26bc	11.63±0.38abc

In a column having similar letter(s) do not differ significantly and figure bearing different letters differ significantly at $P \leq 0.05$ by Tukeys Test.

*T_1=kitchen waste+ cow dung, T_2=kitchen waste+ poultry manure, T_3= kitchen waste + cow dung+ poultry manure, T_4= poultry manure + ash, T_5= poultry manure + saw dust, T_6=poultry manure + ash + saw dust, T_7=only soil

4.2.4 Morphology after 4 months

After 4 months, shoot height of Ghora neem (*Melia azedarach*) seedlings was statistically varied differently among the treatments. Shoot height was higher in T_5 (15.18 cm) and lowest in T_2 (8.43 cm). Number of leaves varied differently among the treatments. Highest number of leaves was recorded in T_4 (22.00 cm) and lowest in T_2 (13.00 cm). Collar diameter was higher in T_4 (5.43 cm) and lowest in T_2 (3.68 cm). Length of central root varied significantly among the treatments. The Longest length of central root was found in T_4 (14.66 cm) and shortest was recorded in other treatments (Table 6).

Table 6: Morphological characteristics of shoot and root of *Melia azedarach* seedlings in different treatments of compost after 4 months

Treatment*	Number of leaves	Shoot height(cm)	Root Collar diameter (mm): D	Central root(cm)
T_1	15±0.71cd	11.33±0.35c	4.23±0.17bc	10.53±0.39bc
T_2	13.25±0.47d	8.43±0.23d	3.68±0.11c	9.65±1.82c
T_3	18.5±0.64b	11.28±0.47c	5.1±0.14a	13.35±0.37ab
T_4	22±0.91a	13.35±0.25ab	5.43±0.03a	14.66±0.27a
T_5	14±0.41d	15.18±0.44a	4.13±0.13bc	13.55±0.38ab
T_6	17.5±0.29bc	13.25±0.66b	4.72±0.21ab	12.05±0.54abc
T_7	19.75±0.85ab	9.25±0.29bc	4.2±0.27bc	12.13±0.52abc

In a column having similar letter(s) do not differ significantly and figure bearing different letters differ significantly at $P \leq 0.05$ by Tukeys Test.

*T_1=kitchen waste+ cow dung, T_2=kitchen waste+ poultry manure, T_3= kitchen waste + cow dung+ poultry manure, T_4= poultry manure + ash, T_5= poultry manure + saw dust, T_6=poultry manure + ash + saw dust, T_7=only soil

4.3 Biomass allocation

4.3.1 Biomass after 1 month

After 1 month, shoot and root dry biomass of *Melia azedarach* seedling varied among different treatments. The highest value of shoot dry biomass was in treatment T_1 (1.16 cm) and the lowest value was in treatment T_2 (0.28 cm). The highest value of root dry biomass was in treatment T_7 (0.17 cm) and the lowest value was in treatment T_3 (0.27 cm). Total dry biomass was recorded higher in treatment T_4 (1.79 cm) and the lowest value was in treatment T_2 (0.62 cm). Shoot/root ratio varied among different treatment. The highest value was in T_6 treatment and the lowest value was in T_2 treatment. Quality index was found higher in treatment T_4 (0.52 cm) and the lowest value was in treatment T_7 (0.21 cm) in different treatments (Table 7).

Table 7: Biomass allocation and quality index of *Melia azedarach* seedlings at different treatments of compost after 1 month

Treatment*	Shoot dry weight (g)	Root dry weight (g)	Shoot/Root ratio	Total dry biomass(g)	Quality index
T_1	1.16±0.04d	0.97±0.02a	0.97±0.03ab	1.21±0.05bc	0.39±0.03b
T_2	0.28±0.03be	0.29±0.02c	0.52±0.02d	0.62±0.05d	0.23±0.02c
T_3	0.51±0.04bc	0.27±0.01b	0.77±0.03c	1.18±0.04bc	0.39±0.0003b
T_4	0.49±0.03a	0.91±0.02a	0.88±0.02bc	1.79±0.04a	0.52±0.02a
T_5	0.56±0.02b	1.16±0.04b	0.98±0.03ab	1.28±0.06b	0.28±0.02c
T_6	0.41±0.02cd	0.31±0.05b	1.12±0.06a	1.06±0.06c	0.29±0.03c
T_7	1.00±0.02de	1.17±0.02c	0.74±0.02c	0.72±0.01d	0.21±0.00094c

*T_1=kitchen waste+ cow dung, T_2=kitchen waste+ poultry manure, T_3= kitchen waste + cow dung+ poultry manure, T_4= poultry manure + ash, T_5= poultry manure + saw dust, T_6=poultry manure + ash + saw dust, T_7=only soil

In a column having similar letter(s) do not differ significantly and figure bearing different letters differ significantly at $P \leq 0.05$ by Tukeys Test.

4.3.2 Biomass after 2 months

After 2 month, shoot and root dry biomass of *Melia azedarach* seedling varied among different treatment. The highest value of shoot dry biomass was in treatment T_4 (0.92 cm) and the lowest value was in treatment T_2 (0.29 cm). The highest value of root dry biomass was in treatment T_4 (0.96 cm) and the lowest value was in treatment T_2 (0.40 cm). Total dry biomass was recorded higher in treatment T_4 (1.88 cm) and the lowest value was in treatment T_7 (0.75 cm). Shoot/root ratio varied among different treatment. The highest value was in T_6 treatment and the lowest value was in T_7 treatment. Quality index was found higher in treatment T_4 (0.53 cm) and the lowest value was in treatment T_2 (0.23 cm) in different treatments (Table 8).

Table 8: Biomass allocation and quality index of *Melia azedarach* seedlings at different treatments of compost after 2 months

Treatments*	Shoot dry biomass(g)	Root dry biomass(g)	Shoot/Root ratio	Total dry biomass(g)	Quality index
T1	0.43±0.04de	0.86±0.02a	1.05±0.05ab	1.28±0.05bc	0.39±0.01bc
T_2	0.29±0.04e	0.4±0.02c	0.95±0.17ab	0.69±0.05d	0.23±0.01e
T_3	0.63±0.04bc	0.65±0.01b	0.86±0.05ab	1.27±0.05bc	0.39±0.01b
T_4	0.92±0.02a	0.96±0.01a	0.93±0.04ab	1.88±0.03a	0.53±0.0008a
T_5	0.68±0.02b	0.69±0.05b	1.12±0.02a	1.38±0.06b	0.27±0.02de
T_6	0.5±0.02cd	0.64±0.05b	1.09±0.05a	1.14±0.07c	0.31±0.03cd
T_7	0.40±0.01de	0.41±0.02c	0.75±0.02b	0.81±0.01d	0.24±0.01de

*T_1=kitchen waste+ cow dung, T_2=kitchen waste+ poultry manure, T_3= kitchen waste + cow dung+ poultry manure, T_4= poultry manure + ash, T_5= poultry manure + saw dust, T_6=poultry manure + ash + saw dust, T_7=only soil

In a column having similar letter(s) do not differ significantly and figure bearing different letters differ significantly at $P \leq 0.05$ by Tukeys Test.

4.3.3 Biomass after 3 months

After 3 month, shoot and root dry biomass of *Melia azedarach* seedling varied among different treatment. The highest value of shoot dry biomass was in treatment T_4 (0.96 cm) and the lowest value was in treatment T_2 (0.35 cm). The highest value of root dry biomass was in treatment T_4 (1.08 cm) and the lowest value was in treatment T_2 (0.44 cm). Total dry biomass was recorded higher in treatment T_4 (2.04 cm) and the lowest value was in treatment T_2 (0.79 cm). Shoot/root ratio varied among different treatment. The highest value was in T_5 (1.13 cm) treatment and the lowest value was in T_7 (0.76 cm) treatment. Quality index was found higher in treatment T_4 (0.59 cm) and the lowest value was in treatment T_2 (0.25 cm) in different treatments (Table 9).

Table 9: Biomass allocation and quality index of *Melia azedarach* seedlings at different treatments of compost after 3 months

Treatments*	Shoot dry biomass(g)	Root dry biomass(g)	Shoot/Root ratio	Total dry biomass(g)	Quality index
T_1	0.48±0.03cd	0.90±0.01ab	1.08±0.01ab	1.38±0.04b	0.42±0.01b
T_2	0.35±0.04d	0.44±0.03d	0.95±0.17ab	0.79±0.05c	0.25±0.01c
T_3	0.68±0.04b	0.7±0.01b	0.86±0.05ab	1.38±0.04b	0.43±0.02b
T_4	0.96±0.02a	1.08±0.11a	0.92±0.03ab	2.04±0.12a	0.59±0.04a
T_5	0.74±0.02b	0.76±0.05b	1.13±0.01a	1.50±0.07b	0.31±0.03c
T_6	0.55±0.02c	0.69±0.05bc	1.09±0.05a	1.24±0.07b	0.35±0.04bc
T_7	0.46±0.02cd	0.47±0.02cd	0.76±0.01b	0.93±0.01c	0.29±0.01c

*T_1=kitchen waste+ cow dung, T_2=kitchen waste+ poultry manure, T_3= kitchen waste + cow dung+ poultry manure, T_4= poultry manure + ash, T_5= poultry manure + saw dust, T_6=poultry manure + ash + saw dust, T_7=only soil

In a column having similar letter(s) do not differ significantly and figure bearing different letters differ significantly at $P \leq 0.05$ by Tukeys Test.

4.3.4 Biomass after 4 months

After 4 month, shoot and root dry biomass of *Melia azedarach* seedling varied among different treatment. The highest value of shoot dry biomass was in treatment T_4 (1.01 cm) and the lowest value was in treatment T_2 (0.41 cm). The highest value of root dry biomass was in treatment T_4 (1.19 cm) and the lowest value was in treatment T_2 (0.47 cm). Total dry biomass was recorded higher in treatment T_4 (2.21 cm) and the lowest value was in treatment T_2 (0.88 cm). Shoot/root ratio varied among different treatment. The highest value was in T_5 (1.13) treatment and the lowest value was in T_7 (0.77 cm) treatment. Quality index was found higher in treatment T_4 (0.67 cm) and the lowest value was in treatment T_2 (0.28 cm) in different treatments (Table 10).

Table 10: Biomass allocation and quality index of *Melia azedarach* seedlings at different treatments after 4 months

Treatments*	Shoot dry biomass(g)	Root dry biomass(g)	Shoot/Root ratio	Total dry biomass(g)	Quality index
T_1	0.53±0.04de	0.95±0.02ab	1.08±0.01ab	1.48±0.04b	0.46±0.01b
T_2	0.41±0.04e	0.47±0.03c	0.98±0.18ab	0.88±0.06c	0.28±0.02c
T_3	0.73±0.04bc	0.75±0.03bc	0.84±0.05ab	1.47±0.05b	0.46±0.02b
T_4	1.01±0.03a	1.19±0.14a	0.91±0.02ab	2.21±0.13a	0.67±0.06a
T_5	0.80±0.03b	0.82±0.05b	1.13±0.01a	1.62±0.08b	0.35±0.03bc
T_6	0.60±0.02cd	0.75±0.05bc	1.1±0.03ab	1.35±0.06b	0.38±0.03bc
T_7	0.52±0.02de	0.50±0.02c	0.77±0.02b	1.02±0.0007c	0.32±0.02c

*T_1=kitchen waste+ cow dung, T_2=kitchen waste+ poultry manure, T_3= kitchen waste + cow dung+ poultry manure, T_4= poultry manure + ash, T_5= poultry manure + saw dust, T_6=poultry manure + ash + saw dust, T_7=only soil

In a column having similar letter(s) do not differ significantly and figure bearing different letters differ significantly at P≤0.05 by Tukeys Test.

4.3.5 Number of FOLR

Table 11 shows the diameter class-wise number of FOLR of *Melia azedarach* seedlings after 1 month of sowing. Number of First Order Lateral Root increased in higher diameter classes over time. From the table it is found that most of the FOLR were recorded in >0.5-1.0 class and gradually decreased in other classes (Table 12).

Table 11: Effect of compost on the diameter class-wise number of FOLR of *Melia azedarach* seedlings after 1 month

Treatment*	Diameter class-wise number of FOLR					Total
	0.1-0.5	>0.5-1.0	>1.0-2.0	>2.0-3.0	>3.0	
T_1	1	6	1	0	0	8
T_2	0	2	4	2	0	8
T_3	0	2	5	2	0	9
T_4	0	5	6	2	0	13
T_5	0	5	4	2	0	11
T_6	0	6	4	2	0	12
T_7	0	6	1	1	0	8
Total	1	32	25	11	0	69

*T_1=kitchen waste+ cow dung, T_2=kitchen waste+ poultry manure, T_3= kitchen waste + cow dung+ poultry manure, T_4= poultry manure + ash, T_5= poultry manure + saw dust, T_6=poultry manure + ash + saw dust, T_7=only soil

Table 12 shows the diameter class-wise number of FOLR of *Melia azedarach* seedlings after 2 month of sowing. From the table it is cleared that most of the FOLR were recorded in >1.0-2.0 class and lower number of FOLR were found in other classes

Table 12: Effect of compost on the diameter class-wise number of FOLR of *Melia azedarach* seedlings after 2 month

Treatment*	Diameter class-wise number of FOLR					Total
	0.1-0.5	>0.5-1.0	>1.0-2.0	>2.0-3.0	>3.0	
T_1	0	2	2	4	3	11
T_2	0	3	3	2	2	10
T_3	0	1	6	3	2	12
T_4	0	4	4	5	4	17
T_5	0	3	5	3	2	13
T_6	0	4	3	4	3	14
T_7	0	2	3	3	2	10
Total	0	19	26	24	18	87

*T_1=kitchen waste+ cow dung, T_2=kitchen waste+ poultry manure, T_3= kitchen waste + cow dung+ poultry manure, T_4= poultry manure + ash, T_5= poultry manure + saw dust, T_6=poultry manure + ash + saw dust, T_7=only soil

Table 13 shows the diameter class-wise number of FOLR of *Melia azedarach* seedlings after 3 month of sowing. From the table it is cleared that most of the FOLR were recorded in >2.0-3.0 class and lower number of FOLR were found in other classes.

Table 13: Effect of compost on the diameter class-wise number of FOLR of *Melia azedarach* seedlings after 3 month

Treatment*	Diameter class-wise number of FOLR					Total
	0.1-0.5	>0.5-1.0	>1.0-2.0	>2.0-3.0	>3.0	
T_1	0	2	2	4	4	12
T_2	0	2	3	3	3	11
T_3	0	1	4	6	4	15
T_4	0	3	3	8	5	19
T_5	0	3	3	5	4	15
T_6	0	2	4	6	4	16
T_7	0	2	3	3	3	11
Total	0	15	22	35	27	99

*T_1=kitchen waste+ cow dung, T_2=kitchen waste+ poultry manure, T_3= kitchen waste + cow dung+ poultry manure, T_4= poultry manure + ash, T_5= poultry manure + saw dust, T_6=poultry manure + ash + saw dust, T_7=only soil

Table 14 shows the diameter class-wise number of FOLR of *Melia azedarach* seedlings after 3 month of sowing. From the table it is cleared that most of the FOLR were recorded in >2.0-3.0 class and lower number of FOLR were found in other classes

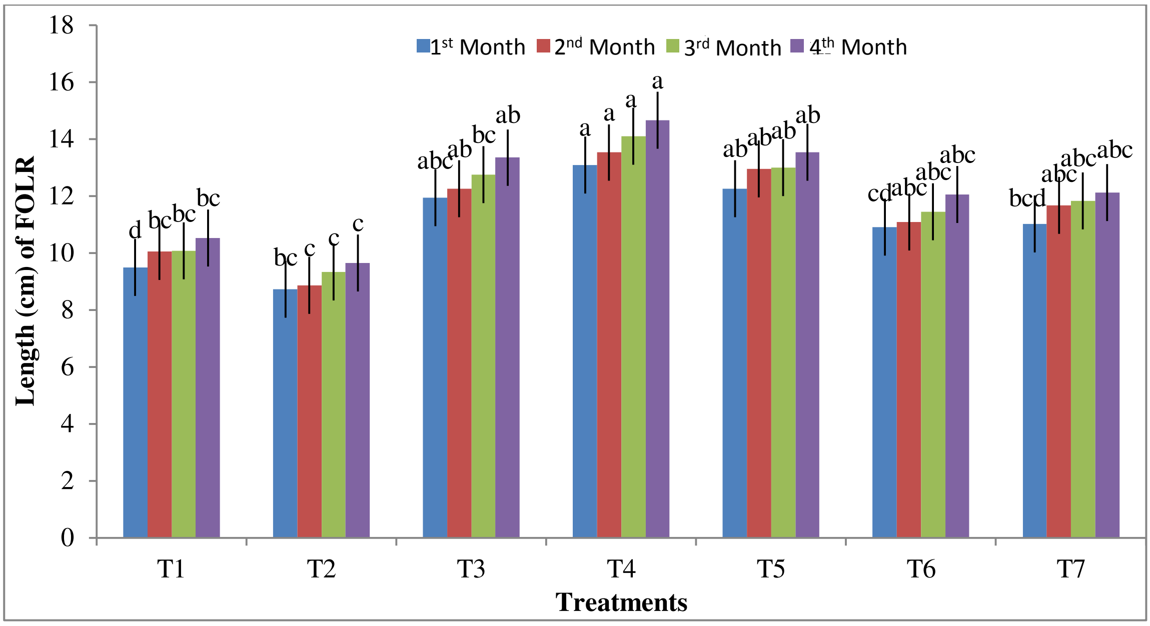
Table 14: Effect of compost on the diameter class-wise number of FOLR of *Melia azedarach* seedlings after 4 month

Treatment*	Diameter class-wise number of FOLR					Total
	0.1-0.5	>0.5-1.0	>1.0-2.0	>2.0-3.0	>3.0	
T_1	0	2	3	4	3	12
T_2	0	1	4	4	2	11
T_3	0	1	3	6	6	16
T_4	0	2	3	8	7	20
T_5	0	2	3	6	5	16
T_6	0	2	5	5	5	17
T_7	0	1	4	3	3	11
Total	0	11	25	36	31	103

*T_1=kitchen waste+ cow dung, T_2=kitchen waste+ poultry manure, T_3= kitchen waste + cow dung+ poultry manure, T_4= poultry manure + ash, T_5= poultry manure + saw dust, T_6=poultry manure + ash + saw dust, T_7=only soil

4.3.6 Mean length of FOLR

Figure 3 shows the mean lengths of all FOLR in different treatments after 1, 2, 3 and 4 months of Mean length of FOLR was recorded higher after 1 month than after 2 months. In case of 1 month, the lowest mean length of FOLR was 10.50 cm and the highest was 13.10 cm of T_4 and T_1 treatments, respectively. After 2 months, the lowest length of FOLR was 8.87 cm and the highest length was 13.53 cm in T_4 and T_2 treatments, respectively. After 3 months , the lowest length of FOLR was 9.34 cm and the highest length was 14.1 cm in T_4 and T_2 treatments at 4 month, the lowest mean length was 9.65cm and the highest was 14.66 cm in T_4 and T_2 treatments, respectively.

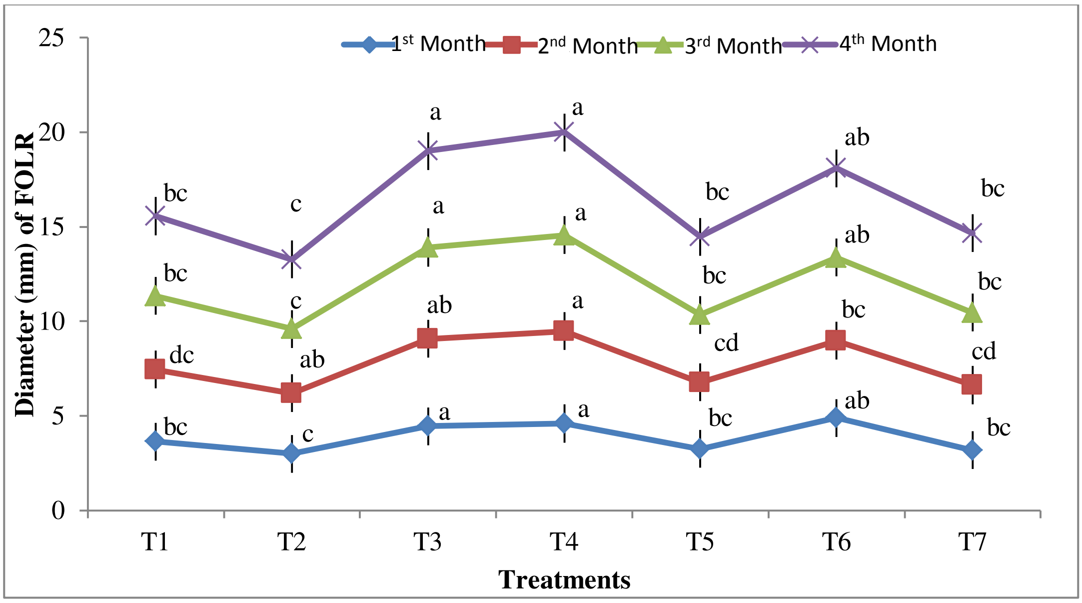


*T_1=kitchen waste+ cow dung, T_2=kitchen waste+ poultry manure, T_3= kitchen waste + cow dung+ poultry manure, T_4= poultry manure + ash, T_5= poultry manure + saw dust, T_6=poultry manure + ash + saw dust, T_7=only soil

Figure 2: Mean length of FOLR of Melia azedarach in different time period among different treatments of compost.

4.3.7 Mean diameter of FOLR

Mean diameter of FOLR varied due to compost among the Ghora neem (*Melia azedarach*) seedlings (Figure 4). Diameter of FOLR increased over time. After 1 month, lowest mean diameter of FOLR plant was recorded 3.0 mm in T_2 treatment and highest was found 4.60 mm T_4 treatment. Similarly after 2 month, mean diameter of FOLR increased in all the treatments. The lowest diameter was recorded 3.2 mm in T_2 treatment and the highest was recorded 4.88 mm in T_4 treatment. After 3 month, the lowest diameter was recorded 3.4 mm in T_2 and the highest was recorded 5.08 mm in T_4 treatments. After 4 month, the lowest diameter was recorded 3.62 mm in T_2 and the highest was recorded 5.43 mm in T_4 treatment.



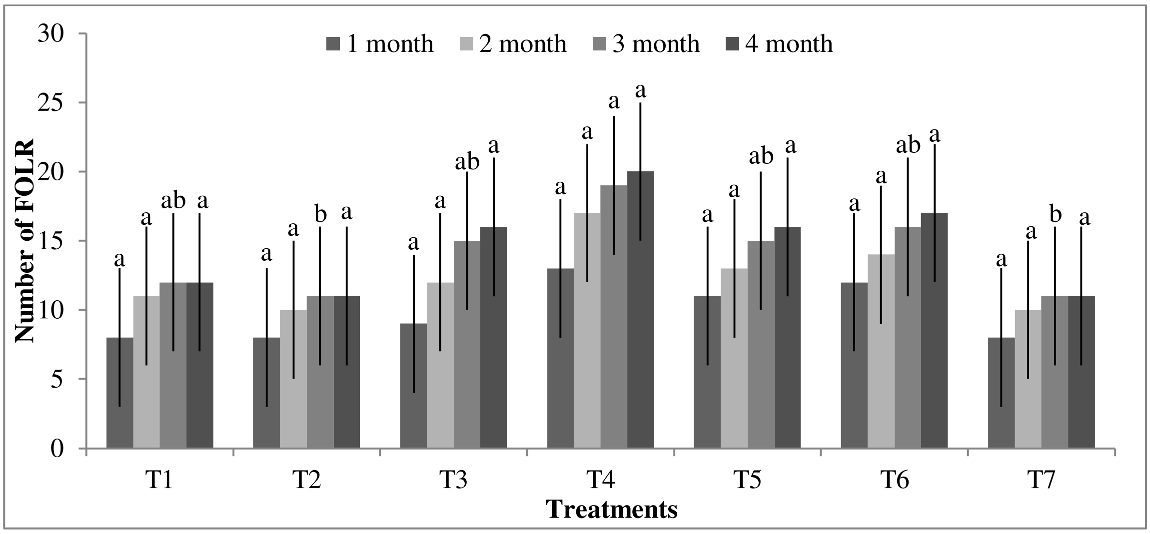
*T_1=kitchen waste+ cow dung, T_2=kitchen waste+ poultry manure, T_3= kitchen waste + cow dung+ poultry manure, T_4= poultry manure + ash, T_5= poultry manure + saw dust, T_6=poultry manure + ash + saw dust, T_7=only soil

Figure 3: Mean diameter of FOLR of Melia azedarach in different time period among different treatments.

4.3.8 Number of FOLR

Number of FOLR of Ghora neem (*Melia azedarach*) seedlings after 1, 2,3 and 4 months of seed sowing is presented in Figure 4. After 1 month, the highest number of FOLR was found in T_4 and the lowest number of FOLR was in T_7. After 2 month, the highest number of FOLR was recorded in T_4 and the lowest number of FOLR was in T_2. After 3 months, the highest number of FOLR was recorded in T_4 and the lowest number of

FOLR was in T_7 and after 4 months, the highest number of FOLR was recorded in T_4 and the lowest number of FOLR was in T_7.



*T_1=kitchen waste+ cow dung, T_2=kitchen waste+ poultry manure, T_3= kitchen waste + cow dung+ poultry manure, T_4= poultry manure + ash, T_5= poultry manure + saw dust, T_6=poultry manure + ash + saw dust, T_7=only soil

Figure 4: Effect of compost on number of FOLR of Melia azedarach in different time period among different treatments.

4.4 Discussions

4.4.1 Morphological parameters

From the result it is observed that average shoot height increased over time i. e. after 1, 2, 3 and 4 months of Ghora neem seed sowing in containers. But within a period there was significant differences recorded among the treatments. This result indicates that Composts was greatly affected in plant height of Ghora neem seedlings at the early stage of their growth. This result may be occurred due to application of different composts on the Ghora neem seedlings. Hedge and Miller (1990) found that plant height and fresh weight per plant of alfalfa and fresh weight per plant of sorghum were lower on alfalfa-soil than on sorghum-soil. As a result, allelopathic/autotoxic compounds in alfalfa-soil were implicated in the growth inhibition of both alfalfa and sorghum.

Average collar diameter of ghora neem seedlings was gradually increased in mud containers after 1, 2, 3 and 4 months. It is clear that collar diameter was influenced by different composts. This result may be due to application of composts.

In this experiment, highest number of leaves of Ghora neem seedlings was recorded in treatment T_4 and the lowest in T_2. In the same case was occur in central root length of Ghora neem seedling. From the result we said that this result may occur in due to application of different composts. This result is in agreement of Cochrane (1948) where he found that due to higher concentration plant growth may inhibit.

4.4.2 Biomass parameters

From the present research findings, the shoot dry biomass of ghora neem seedlings increased over time in all the treatments after 1, 2, 3 and 4 months. Same result was found in root dry biomass, total dry biomass, root/root ratio, quality index also. This result is in conformation with Hasan *et al.* (2004) in wheat varieties where they found that shoot dry biomass increased significantly with increasing temperature.

4.4.3 Architecture of FOLR(s)

Root architectural analysis showed that after 4 months, the highest (14.66 cm) mean length of First Order Lateral Roots (FOLR) was found in poultry manure + ash and lowest was found in kitchen waste + poultry manure (9.65cm).In case, the same result was found in number of FOLR. Though there is variation in number and diameter of FOLR but they did not vary significantly after 1, 2, 3 and 4 months of seed sowing. Han *et al.* (2008) found that rhizome, stem and leaf aqueous extracts of ginger inhibited seed germination and seedling growth of soybean and chive.

CHAPTER 5

SUMMARY, CONCLUSION AND RECOMMANDATIONS

CHAPTER 5

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Summary

A experiment was conducted at the departmental research field of Agroforestry and Environment, Hajee Mohammad Danesh Science and Technology University, Bangladesh during the period of October 2016 to April 2017 to find out the effect of Compost on the germination, root architecture and shoot growth of Ghora neem (*Melia azedarach* L.) seedling.

The experiments were laid out in complete randomized design. The Experiment was conducted in mud containers. There were seven treatments of compost including control viz. T_1 (kitchen waste + cowdung), T_2 (kitchen waste + poultry manure), T_3 (kitchen waste + cowdung + poultry manure), T_4 (poultry manure + ash), T_5 (poultry manure + sawdust), T_6 (poultry manure+ ash+ sawdust) and T_7 (only soil, Control). The data were calculated with Statistix10 software and MS Excel 2010.

The results of the research showed that germination percentage and number of shoots were positively affected by different composts. Ghora neem seeds showed better germination in all the treatments of composts. The highest germination percentage was calculated 75% in T_4 (poultry manure+ ash) treatment followed by 50% in T_3 (kitchen waste + cowdung + poultry manure) treatment, 43.75% T_6 (poultry manure + ash + sawdust) in treatment and lowest germination percentage was recorded 25% in T_1 (kitchen waste + cowdung). Highest germination speed was found in T_4 followed by T_3, T_6, T_5, T_7, T_2 and lowest in T_1.

The morphology of shoot and roots and their biomass were measured in four times which are as follows:

a) initial measurement on 8th January 2017, b) second measurement on 8th February 2017 c) Third measurement on 8th March 2017 and d) Fourth measurement on 8thApril.

From the result it is observed that average shoot height, root collar diameter, number of leaves, central root length increased over time i.e. after 1, 2, 3 and 4 months. But within a period, there was significant differences recorded among the treatments. These results indicate that different type of composts was greatly affected significantly in shoot height, root collar diameter, number of leaves, central root length of *Melia azedarach* L.

In case of biomass allocation, it was observed that shoot dry biomass, root dry biomass, total dry biomass, shoot/root ratio and quality index were not statistically similer among the treatments after 1 and 4 months. After 4 months, shoot dry biomass was recorded highest (1.01g) T_4 (poultry manure + ash) in and lowest (0.41g) in T_2 (kitchen waste + poultry manure). Highest root dry biomass (1.19g) was found in T_4 (poultry manure + ash) and lowest (0.47g) in T_2 (kitchen waste+ poultry manure). Total dry biomass was found significantly highest (2.21g) in T_4 (poultry manure + ash) and lowest (0.88g) in T_2 (kitchen waste+ poultry manure). Shoot/root highest in ratio T_5 (poultry manure + sawdust) and lowest (0.77g) in T_7 (control). Significantly the highest quality index was recorded in T_4 following T_1 (kitchen waste + cowdung), T_3 (kitchen waste + cowdung + poultry manure), T_6 (poultry manure + ash + sawdust), T_5 (poultry manure + sawdust) and lowest (.28g) in T_2 (kitchen waste + poultry manure) after 4 months.

The highest number of leaves was recorded in T_4 (poultry manure + ash) treatment and T_2 lowest in (kitchen waste + poultry manure) treatment. The Longest length of central root was found in T_4 (poultry manure + ash) treatment and shortest was recorded in T_2 (kitchen waste + poultry manure) treatments.

5.2 Conclusion

From the results and foregoing discussion, it is clear that almost all composts have a positive effect on germination, morphological growth shoot and root and the root architecture of Ghora neem seedling. Among the six combinations of compost with soil, poultry manure and ash contributed highest germination and growth compared to other composts. This might be the due to high heat generation which helped to break the dormancy of the hard seed coat of the tested seeds. Therefore, composts specially poultry and ash can be used for the successful seed germination and better growth of Ghora neem seedling.

5.3 Recommendations

From the experiment the following suggestions can be recommended:

- The research was conducted in muddy containers. Therefore, further research can be recommended in the open field condition.
- The experiment was conducted in winter season. Further research should be done in summer season.
- Heat generation by different composts and their chemical composition can be identified for further research.

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APPENDICES

APPENDICES

Appendix I: The soil properties of Agroforestry and Environment farm HSTU, Dinajpur

Soil characters	**Physical and chemical properties**
Texture	
Sand (%)	67
Silt (%	33
Clay(%	5
Textural class	Sandy loam
CEC (meq/ 100g)	8.00
pH	6.1
Organic matter (%)	1.25
Total nitrogen (%)	0.10
Sodium (meq/ 100g)	0.06
Calcium (meq/ 100g)	1.30
Magnesium (meq/ 100g)	0.40
Potassium (meq/ 100g)	0.26
Phosphorus (µg/g)	25.0
Sulphur (µg/g)	3.1
Boron (µg/g)	0.28
Iron (µg/g)	5.30
Zinc (µg/g)	0.90

Source: Soil Resources Development Institute, Dinajpur (2016).

Appendix II: Monthly records of different weather data at the period from April 2016 to July 2017

Month	** Air Temperature (ºC)			**Relative Humidity (%)	*Rainfall (mm)	*Sunshine (hrs.)
	Maximum	Minimum	Average			
April	21.8	18.0	19.9	83.0	1.0	269.7
May	32.8	21.1	26.9	85.0	54.0	280.4
June	32.9	22.7	27.8	90.0	425.0	250.1
July	35.5	27.6	31.5	92.0	538.0	220.1

* Monthly Total

** Monthly average

Source: Wheat Research Centre (WRC), Nashipur, Dinajpur.

Appendix-III(a): Descriptive Statistics of Shoot height of Ghora neem influence by composts in muddy containers after one months.

Treatment	N	Mean	SD	SE Mean	C.V
T_1	4	9.47	0.71	0.35	7.51
T_2	4	5.89	0.71	0.35	12.09
T_3	4	9.16	0.4	0.2	4.38
T_4	4	11.62	0.27	0.13	2.28
T_5	4	11.9	0.89	0.45	7.48
T_6	4	11.69	1.73	0.87	14.8
T_7	4	7.9	0.27	0.14	3.43

Appendix-III(b): Analysis of variance of Shoot height of Ghora neem influence by composts in muddy containers after one months

Source of variance	Degrees of Freedom	Sum square values	Mean Sqare Values	F Values	P Values
Treatment	6	122.41	20.4	27.98	0
Error	21	15.31	0.73		

Appendix-IV(a):Descriptive Statistics of Shoot height of Ghora neem influence by composts in muddy containers after second months.

Treatment	N	Mean	SD	SE Mean	C.V
T_1	4	10.57	0.44	0.22	4.16
T_2	4	7.55	0.52	0.26	6.88
T_3	4	10.43	0.84	0.42	8.08
T_4	4	12.53	0.61	0.31	4.89
T_5	4	14.17	0.88	0.44	6.19
T_6	4	11.93	1.61	0.8	13.47
T_7	4	8.25	0.31	0.16	3.55

Appendix-IV(b): Analysis of variance of Shoot height of Ghora neem influence by composts in muddy containers after second months.

Source of variance	Degrees of Freedom	Sum square values	Mean Sqare Values	F Values	P Values
Treatment	6	131.56	21.93	30.73	0
Error	21	14.99	0.71		

Appendix-V(a):Descriptive Statistics of Shoot height of Ghora neem influence by composts in muddy containers after Third months.

Treatment	N	Mean	SD	SE Mean	C.V
T_1	4	10.83	0.53	0.26	4.85
T_2	4	7.93	0.6	0.3	7.59
T_3	4	10.85	0.91	0.46	8.39
T_4	4	13	0.45	0.23	3.49
T_5	4	14.63	0.85	0.43	5.84
T_6	4	12.43	1.61	0.81	12.98
T_7	4	8.75	0.31	0.16	3.55

Appendix-V(b): Analysis of variance of Shoot height of Ghora neem influence by composts in muddy containers after Third months.

Source of variance	Degrees of Freedom	Sum square values	Mean Sqare Values	F Values	P Values
Treatment	6	133.85	22.31	30.6	0
Error	21	15.31	0.73		

Appendix-VI(a):Descriptive Statistics of Shoot height of Ghora neem influence by composts in muddy containers after Four months.

Treatment	N	Mean	SD	SE Mean	C.V
T_1	4	11.33	0.69	0.35	6.18
T_2	4	8.43	0.46	0.23	5.51
T_3	4	11.28	0.95	0.47	8.39
T_4	4	13.35	0.51	0.25	3.79
T_5	4	15.18	0.88	0.44	5.83
T_6	4	13.25	1.31	0.66	9.89
T_7	4	9.25	0.34	0.17	3.69

Appendix-VI(b): Analysis of variance of Shoot height of Ghora neem influence by composts in muddy containers after Four months.

Source of variance	Degrees of Freedom	Sum square values	Mean Sqare Values	F Values	P Values
Treatment	6	136.987	22.8312	35.73	0
Error	21	13.42	0.639		

Appendix-VII: Some Research Photographs

Plate 2: Collection and measurement of Composts from Crop Physiology Research Field

Plate 3: Composts mixed with soil

Plate 4: Ghora neem seed shown in muddy containers by hands

Plate 5: Irrigation application in muddy containers

Plate 6 : Data collection in my research field

Plate 7: Morphological measurement of Ghora neem seedlings

Plate 8: Root and shoot separation of Ghora neem seedlings in Agroforestry Laboratory

Plate 7: Biomass measurement of Ghora neem seedlings