1. INTRODUCTION

1.1 GENERAL INTRODUCTION

Soil is formed as a result of weathering of rocks and minerals. Weathering is the disintegration and decomposition of rocks and minerals by physical and chemical processes. The universally accepted terminology was defined by Joffee (1936) as "Soil is a dynamic natural body of mineral and organic constituent". Soil is a living system with a series of physical, chemical and biological reactions that determine the potential fertility status. The soil is a habitat for vast complex possessing interactive community of soil organisms whose activities largely determine the chemical and physical properties of the soil and growth of the plants. From seed germination until a plant reaches maturity it lives in close association with soil organisms, termed as rhizocoenosis (Saxena, 1994). It is also possible that the normal physiological functioning of an established root system may be impaired considerably by an unfavorable physical condition of the soil. In such an instance, the roots will die and nutrients absorption will be restricted. Finally it is an established fact that a good physiological environment for the plants is one that permits good microbial activities. The roots of plants must be well distributed throughout a given volume of soil in order to reach all types of substrates of the soils. The soil solution will not move to the roots, the roots have to move to the soil solution. Any soil condition that
restricts the development of an extensive root system will therefore affect the efficient utilization of applied fertilizers.

India is an agro based country. But agriculture is a practice which earns very small profit compared to the hardships involved in it. The development of our country therefore largely depends on the development of agriculture. During the last quarter of the century, significant development has been made in different fields of Indian agriculture. To increase the production capacities of the land and to uplift the economical status of farmers the green revolution was started in the 1960’s. The major resources required to increase agricultural and aquacultural productions are land, water, soil, seeds, manures etc., Among these, manure plays a vital role in augmenting the production.

1.2 MODERN AGRICULTURE

Under green revolution chemical fertilizers, pesticides, hybrid seeds etc. are innovated to increase soil productivity and all these chemical products were made easily available to farmers through markets and subsidies. Use of chemical fertilizers and hybrid seeds has certainly boosted land productivity to many folds. The demand for fertilizers in India increases substantially every year and surpasses domestic production. The excess fertilizer demand is met by imports but the import of fertilizers is not economical, as they are expensive (Naika and Gracy, 1996). Use of chemical fertilizers is enforcing both plants as well as soils to be sick in terms of nutritive value. It is also the major cause for most of the disease affecting living beings besides causing disastrous consequences to nature (Ghosh, 2000). Modern crop production technology has considerably raised the
output but has created problems of land degradation, pesticide residues in farm produce, atmosphere and water.

Modern technologies of agriculture as well as other developmental activities of modern society are highly exploitative in nature besides enhancing pollution and causing enormous damage to the environment. Increased doses of nitrogenous fertilizers are polluting water bodies with high levels of nitrates. Pesticide residues in the soil contaminate water bodies. The developmental activities including agriculture hasten the degradation of land, denudation of forest and loss of aerable land. The byproducts of chemical fertilizer are the soil erosion, water pollution and chemical residues in food (Fitzimons, 1996).

1.3 NEED FOR ORGANIC FARMING

The slow poisoning of soil by chemical fertilizer is one of the calamities facing agriculture. As a result of continuous use the soil becomes depleted year after year and earth is drained off its vitality soon, making it difficult to sustain soil fertility (Rajasekharan, 1995). The extensive use of chemical fertilizers in modern farming is based on fossil fuel, which is practically a finite non-renewable source of energy, undergoing steady depletion. These chemicals besides causing drastic environmental problems leave behind residues in the land we live, air we breathe, water we drink and food we eat causing innumerable damage to human health and create a chain of ecological and economic problems. The crop yield has been drastically reduced due to the decline in soil nutrient resources. The residual effects of some herbicides inhibit nodulation of legume crops. In any case the toxins of pesticides and herbicides are
absorbed by plants and passed onto the food chain (Ghosh, 2000). Soil physical properties such as bulk density, porosity and stability of aggregates and biological properties are affected by the continuous application of fertilizers.

Uncontrolled population growth in India accelerated the imbalance between human needs and sustainable use of land. There is a need for urbanizing human kind and biosphere reserves which is only possible through organic farming. A transition from chemical to sustainable agriculture takes 3-6 years. This is the time required to trigger the soil biology to get the same yields without excessive reliance on chemical fertilizers and pesticides. This time duration however could be brought down to three months (Bhawalker, 1995) by harnessing vermiculture biotechnology to the soil. The increasing cost of fertilizers, growing ecological concern and conservation of energy have in recent times spurred considerable interest in the use of organics as sources of plant nutrients as well as to accelerate the activity of microbes in building up the soil fertility (Tiwari and Mishra, 2000). Presently the challenge before us is to achieve the sustained growth rates high enough to feed enormous population without degrading the environment. So eminent scientists are now calling for evergreen revolution which can be achieved through sustainable agriculture (Parr et al. 1990). Sustainable agriculture is a form of agriculture aimed at meeting the needs of the present generation without endangering the resource base of the future generations. Sustainable agriculture mainly depends on soil organic matter for nutrient supply through animal dung, compost and green manures. The main advantages of sustainable agriculture are ecological balance, low cost of cultivation, clean environment and nutritious food without residues that harm human health (Bhatnagar and Patla, 1996). In sustainable agriculture, chemical, physical and biological
methods are given prime importance. Organic manure plays an important key role for achieving sustainability in agricultural production because many desirable soil properties exert beneficial effect on the physical, chemical and biological characteristics of the soil. For switching over to organic farming from chemical farming the following points have to be borne in mind.

- Usage of compost instead of chemical fertilizers.
- Usage of bio-pesticides instead of chemical pesticides.
- Usage of indigenous seeds instead of hybrid seeds.

1.4 IMPACT OF ORGANIC FARMING

The change from chemical to organic agriculture is not very simple. It requires a lot of understanding on the part of farmers to develop organic farming successfully. The experiences of the successful organic farming may be documented and made available to other farmers so that they could be convinced that the organic farming can be economical, rewarding, challenging and environmentally safe too (Chander, 1996). Considering the chemical fertilizers as a whole their adverse effects are immense in many ways. The chemical fertilizers reduce soil organic matter, soil porosity, impede oxygen flow, reduce water holding capacity of soil and obstruct natural nitrogen fixation soil bacteria.

The concept of sustainable agriculture has three major objectives

- Food security
- Employment and income generation in rural areas
- Natural resources conservation and environmental protection
Organic agriculture is a production system that avoids or largely excludes the use of chemical fertilizers, pesticides and growth regulators. To the maximum extent feasible, organic farming system relies upon crop rotation with leguminous crop, addition of crop residues, animal manures, green manures, biofertilizers and bio pesticides (Motsara, 2000). It is environmental friendly as it conserves the ecological base of farming and does not cause pollution in the atmosphere, soil and water bodies. It also augments the local availability of biomass for use as source of renewable energy to satisfy the increasing energy needs of rural households (Thampan, 1995). During each season substantial amount of plant nutrients are removed from soil by crop harvesting (Gaur, 1978). Crop residues are an important source of nutrients and are also known to improve the physical and biological properties of soil (Venkateswaralu and Hedge, 1992). Incorporation of residues improves the soil fertility, returning crop residues improve soil physical properties, water relationship, nutrient availability and crop yield.

1.5 SOIL ORGANIC MATTER

The importance of organic matter was recognized by man even before he knew the real significance of it. From time immemorial it has been realized that the dark coloured soil, commonly seen in the river valleys and broad level plains, are usually very productive (Allison, 1973).

Sources of soil organic matter

The primary source of soil organic matter is

- Plant tissues as tops and roots of the trees.
- Shrubs, grasses, remains of harvested crops, green manuring.
Soil organisms (Secondary source), waste products of animals, cattle dung, remains of animals after completion of life cycle

Other sources

- Household (rural city waste) food waste
- Slaughter house waste
- Industrial waste (food and fibre waste)
- Sugar factory waste (Bagasse, press mud, molasses etc.)
- Composts and Biogas slurry.
- These waste materials are added to soil as sources of soil organic matter.

Organic matter plays a key role in improving soil physical conditions. It improves soil aggregation which in turn influences infiltration, movement and retention of soil water, aeration, temperature, soil strength and root penetration.

1.6 ORGANIC MATTER IN MAINTAINING SOIL FERTILITY

- Organic matter binds up soil particles into structural units called aggregates. These aggregates help to maintain a loose open granular condition. Water infiltrates and percolates more readily. The granular condition of soil maintains favorable condition of aeration and permeability.
- Organic matter supplies food for soil microflora and other organisms such as earthworm, ants, rodents etc. These micro organisms improve drainage and aeration. Earthworms can flourish only in a soil that is enriched with organic matter.
- Organic manures help in increasing the water holding capacity
- Organic matter content strongly affects the soil fertility by increasing the availability of plant nutrients, by improving the soil structure and water
holding capacity and by its action as an accumulation phase for toxic, heavy metals in the soil environment (Stevenson and Fitch, 1981)

- The important physico-chemical properties *viz.*, cation exchange capacity (Sanchez, 1976; Drake and Motto, 1982) and soil buffering capacity are influenced considerably by the soil organic component.

- Water holding capacity of soil is increased by organic matter. Organic matter definitely increases the amount of available water in sandy and loamy soils. Further, the granular soil resulting from organic matter addition, supplies more water that aggregates the impervious soil.

- Surface runoff and erosion are reduced by organic matter as there is good infiltration.

- Surface mulching with coarse organic matter, lowers soil temperature in the summer and keep the soil warmer in winter.

- The organic matter serves as a source of energy for the growth of soil micro - organism.

- Organic matter serves as a reservoir of chemical elements that are essential for plant growth.

- Fresh organic matter has a special function in making soil phosphorus more readily available even in acid soils.

- Organic acids released from decomposing organic matter help to reduce alkalinity in soil.

- Organic matter upon decomposition produces organic acids and Carbon-di-oxide which helps to dissolve minerals such as potassium and make them more available to growing plants.

- Highly decomposed organic matter provides a store-house for the exchangeable and available cations – potassium, magnesium and ammonium.

Directly, organic matter acts as a source of plant nutrients and indirectly, it influences the physico-chemical properties. Natural manure application stabilizes organic matter in the soil, which improves soil properties like water holding capacity, soil
temperature, soil structure, base exchange capacity, microbial population, their activities and resistance to soil erosion.

1.7 COMPOSTING

Composting is the microbiological conversion of biodegradable organic waste to a stable humus by indigenous flora, including bacteria, fungi and actinomycetes, which are widely distributed in nature. The organic waste such as crop residues, dung and urine from domesticated animals, slaughter houses waste, human excreta, sewage, biomass of weeds, and organic waste from fruit, vegetable, household waste, sugarcane trash, oil cakes, press mud and fly ash from thermal power plants can be effectively recycled. Gaur (1982) demonstrated that the best compost was prepared when crop residues and animal dung were mixed together in the ratio 3:1.

Composting is a dynamic process brought about by the succession of mixed microbial populations with specific functions, all of which are interested in the total process. These organisms represent both the plant and animal kingdoms (Biddlestone and Gray, 1985). Many of the soil animals break the composting material into small particles increasing the surface area for microbial attack. They also make a contribution to the mixing of the various constituents (Biddlestone and Gray, 1985).

The phospho compost can be used as effective organic amendments for problem soils like acid soils. On application to soil it produces favourable liming effect, minimize phosphate fixing capacity and improves the water retention and infiltration capacity in acid soils (Sathiyabama et.al., 2001).
Use of microbial inoculants (Gaur, 1972) was found effective, since organic acid liberated by the activity of heterotrophic micro flora is responsible for dissolution of those insoluble phosphates. Moreover the agronomic effectiveness could be increased by the application of organic manure in conjunction with rock phosphates (Sharma et al. 1981). Acidulation with mineral acids could also augment the phosphate availability (Shinde et al. 1992, Dash and Patra 1977) in soil. Saha et al. (1992) reported that phosphorus extractability increased with decomposition.

In India, vermiculture is being increasingly used to sustain soil fertility, reclaim waste land and to treat solid waste. Vermiculture can also be practiced in all plantation crops to avoid soil disturbances through mechanical tillage. It can also decrease soil pH, increase potash content and improve crop yield besides enhancing compost production (Dhall, 2001).

Several researchers have used various organic materials like cassava peal, poultry manure, tannery waste, hospital waste, solid paper mill sludge, biological sludge and few weeds for vermiculture and vermicomposting (Mba, 1983; Bano and Kale 1986; Karmegam et al., 1997 and Masciandaro et al., 1997).

Earthworms act as decomposers of plant remains during its passage down the gut that promotes growth of humus creating bacteria such as actinomycetes besides gluing together soil particles into aggregates. Being water soluble, these soil aggregates are responsible for clump structure which makes the soil loose and facilitates penetration of air, moisture and roots (Dhall, 2001). The nutrients increased in the matured compost is the fact that during mineralization of waste in the worm gut there is an increase in the nutrient content as has been reported by Ramesh and Gunathilagaraj (1996).
The superiority of vermicompost over other composts was also reported by Bhawalkar (1995) and Singh and Rai (1998). Earthworms are highly sensitive to the soil physico-chemical environment and serve as true bio-indicators of soil quality (Paoletti et al. 1991). The application of vermicompost promotes the growth of plants and it was attributed to the presence of chemical stimulants in the vermicompost. These chemical stimulants induced phyto harmones which are responsible for the production of root and shoot growth (Pearce et al. 1968). The excreta or castings of the earthworm are rich in nitrates, available forms of phosphorous, potassium, calcium and magnesium.

Chemical analysis of vermicastings show that they contain up to two times as much available magnesium, 5 times as much available nitrogen, 7 times available phosphorous and 11 times as much potassium compared to the surrounding soil.

The vermicastings are also endowed with different enzymes and growth promoting substances besides being rich in vitamins and antibiotics. A number of beneficial microbes including the nitrogen fixing bacteria, proliferation in the earthworm dropping and all the nutrients are available in a ready to use form to the plants. Adding earthworm cast to soil improves greatly the structure and fertility. In the soil, earthworm cast usually has a higher pH, nitrate nitrogen, organic matter, total and exchangeable magnesium, available phosphorous, base capacity and maximum moisture content (Lunt and Jacobson, 1944).

Biogas is a product of fermentation of organic waste in the absence of air with the help of microorganisms to break down the materials through intermediates such as alcohol and fatty acids and finally to methane, CO₂ and water. Biogas yield depends on several factors such as digestion, C:N ratio, pH of digester contents etc.
Biogas slurry is an excellent manure and the use of bio gas slurry in proper combination with chemical fertilizer improves the physical properties of the soil (Jain, 1993). Biogas slurry is a well decomposed compost and is rich in NPK. It also contains trace elements like Zinc and Iron. It has increased manuring effect than decomposed dung since it contains greater amount of water soluble nitrogen, which can be easily made available to plants (Krishnappa et al., 1977). The nutrients in the slurry make the crops absorb and utilize 50-60% nitrogen, which is in a readily available form. The contents nutrients i.e. NPK are high in biogas slurry and act as an effective agent in improving soil properties (Meng Xun et al. 1991).
1.8 JUSTIFICATION

Composting has been in vogue from time immemorial and it is the best cost effective and environmentally benign process of reducing/reusing vegetable and animal refuse (rural/urban) to a quickly utilizable condition for crop lands by improving soil fertility. Further, two major problems confront us today.

- Environmental pollution due to dumping of organic wastes
- Impact of chemical and pesticides residues

By subjecting these wastes of different kinds to bio-degradation the twin problems can be solved and even can be followed elsewhere also where similar types of wastes are generated. Considering the chemical fertilizers as a whole the adverse effects are immense in many ways. They reduce soil organic matter, soil porosity, impedes oxygen flow, reduces water holding capacity of the soil, obstructs natural nitrogen fixation by soil bacteria besides natural control mechanism that affects the soil flora and fauna, reduce the soil's resistance to extreme weather conditions, deplete the trace elements essential for the healthy growth of plants, animals and microbes and pollute the ground and surface water in the neighborhood into which unabsorbed fertilizer drain. Residues of pesticides along with the combination of chemical fertilizers persist in the soil, for 3 – 15 years depending on the type.

Organic agriculture is comparatively free from the complex problems identified with modern agriculture. It is basically a sustainable farming system and bestows many benefits to the practicing farmers. The system produces multiple outputs and opens up diverse sources of income and employment to the rural families.
1.9 OBJECTIVES

- To compare two types of organic substrates *viz.*, *Cassis auriculata*, *Cassia angustifilia* for bio conversion.
- To covert two types of organic substrates into bio compost through ten different methods.
- To understand the physico-chemical characteristics of the substrates used before and after composting.
- To check the microbial load of the composts by ten different methods.
- To evaluate the growth of groundnut and coleus saplings in the compost applied plots.
1.10 SCOPE OF THE PRESENT STUDY

To study the growth of groundnut and Coleus saplings with reference to the impact of ten different types of composts. The present study on Coleus and groundnut in Tirunelveli – a southern most Coleus growing belt, will pave way for their increased yield in future.

In addition, the identification of a suitable method of composting for each substrate will pave way for the easy and effective recycling of the valuable and precious agro-wastes. The evaluation of the best method with best agro-waste for groundnut and coleus species cultivation helps the farm people to achieve sustainable high yield with eco friendly, natural enrichment system.