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Introduction

Organic agriculture is defined as a production system that sustains the health of soils, ecosystems, people and it depend on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic farming combines science, creativity, and tradition to benefit the environment as a whole, foster equitable interactions, and contribute to a high standard of living (EuropeAid, 2012)

Agriculture practises that are economically, environmentally and socially viable are referred to as sustainable agriculture. It encourages all agricultural systems to work toward achieving the standards. Sustainable agriculture encompasses every facet of conventional agriculture as well as numerous alternative farming techniques (Panda, 2013).

India is one of the agricultural based nation that play an important role in the overall socio-economic process and is one of the largest economic sectors. India has a large number of successful sustainable agricultural practices that are in par with ecological principal. For the last 30 years, farming practices has been changed for the better production of yield. Agriculture depend on several resources such as soil, nutrient, energy and water.

Over thousands of years, agriculture has been the main source of human wealth, and it continues to do so now, supporting half of the world's population. Prior to independence, Indian agriculture was sometimes referred to as a monsoon gamble. Small and marginal farmers who produced food and basic animal products for their families dominated our old farming system.

Agriculture covers about 38% of the land area on Earth. Agriculture is a major source of greenhouse gases, biodiversity loss, pesticide pollution, and soil degradation even while it produces increasing amounts of food and other things (Bruinsma, 2017; Godfray *et al.*, 2010). Organic matter plays a vital role for achieving sustainability in agricultural production since it possesses a desirable properties such as water holding capacity, cation exchange, ability to isolate contaminants (both organic and inorganic) and have advantageous effects on the physical, chemical and biological character in soil (Ismail, 1997; Gajalakshmi *et al.*, 2002).

Farmers have long practised organic farming, dating back thousands of years. In India, organic farming became well-known as a farming method substitute for chemical agriculture in the 1940s. The entire agricultural system in ancient India was based on organic farming, where manures, pest and disease control techniques were implemented, and Indian civilisation flourished because of organic farming.

The global desire for safe and healthy food, long-term sustainability, and environmental degradation has made organic farming a significant focus topic (Madhi *et al.*, 2010). Intensive use of inorganic fertilizers and pesticides increased the crop production for short duration but depletion of soil fertility was noticed in soils which leads to degradation of environment. According to Aher *et al.*, (2012) besides the yield comparison, Organic farming increased the amount of organic matter in the soil, utilised less energy, lower external input, and produced better-quality food.

Organic farming excludes the use of synthetic product such as fertilizers, pesticides, growth regulators and livestock feed additives to the maximum and maintain soil productivity, supply plant nutrients, control insects, weeds and other pests by enhancing natural processes and cycles in harmony with environment. Due to environmental concerns, there has been a considerable surge in support for organic or ecological farming (Barik, 2017; Poudel *et al*., 2012). Organic farming preserves agricultural leftovers, animal manures, legumes, green manures, farmyard manure, and healthy crop rotations. As alternatives, organic waste and biofertilizers provide crops with the nutrients they need (Faheed and Fattah, 2008).

Organic farming may generate a lower amount of yield When compared to conventional farming but it is more profitable, eco-friendly and provides food that is equally as nutritious or even better because it contains no residue from pesticides or fertilizers that could cause health problems. Organic wastes nutrient can be recovered and recycled as a soil organic fertilizers or amendment using different technologies. Use of organic wastes can enhance the soil fertility, minimising environmental impact (Thangarajan *et al.*, 2013).

About 3000 million tons of organic waste annually were produced in India which can be recycled and converted into eco-friendly manure for sustainable environment (Achsah and Lakshmi, 2013). Tonnes of municipal solid waste is disposed every year due to hot weather and lack of proper infrastructure for storage, has been disposed off in every nook and corner of the street in the city. Large-scale disposal of industrial, municipal, and agricultural waste

has emerged as a significant global problem that contributes to a variety of environmental pollutants. India wastes over 1,88,500 tonnes of municipal solid trash every day (Prashant, 2013)

Municipal solid waste generation is a normal part of human existence. As a result of an increased standard of living and social standing, the amount of municipal solid trash that is produced is directly correlated with the economic growth of the population in terms of kg/capita/day (Kumar and Kaushal, 2015). The range of municipal solid waste generation is between 0.3 and 0.6 kg/capita/day in Indian cities and annual increase in municipal solid waste generation by volume is estimated as 1.33% per capita (Pattnaik and Reddy, 2010).

Disposal of solid waste in open dumps, inactive landfill or active landfill may increase the risk of health in human beings, causing damage to ecosystems and escalates the destruction of the environment. India is the second largest producer of fruits (81.285 million tonnes) and vegetables (162.19 million tonnes) in the world. According to data from CIPHET- Central Institute of Post-Harvest Engineering and Technology, due to a lack of suitable storage areas and refrigerated transports, fresh produce worth Rs. 13,300 crore is wasted every year (Bhosale, 2013).

Based on origin, food wastes are grouped into two types such as animal or vegetable waste. Within the animal waste, the main sources of wastes are derived from the dairy, meat, fisheries and seafood processing industries. Vegetable wastes may come from a variety of sources, including grains, roots, tubers, oil crops, pulses, fruits, and vegetables (Galanakis *et al.,* 2015). Disposal from human activities has become increasingly harmful all around the world. Burning of trash in open pits might be a significant source of air pollution and could also contaminate surface and ground water, endangering the public health (Seethadevi, 2014).

Fruits and vegetables, root and tuber have the highest wastage rates of any food. According to FAO, (2016) roughly 30 % for cereals, 40-50 % for root crops, fruits, vegetables, 20% for oilseeds, meat, dairy and 35% for fish are wasted annually all around the world. Vegetable waste is a biodegradable waste generated in large quantities (Vegetable waste includes peels, shells, rotten and scraped portion which emit foul odour) (Singh *et al.,* 2012).

Fruits and leafy vegetables are commonly used for culinary and dietary purposes that are made up of cellulose, hemicellulose and pectin substrates. Fruits and vegetables are low in fats (saturated fat and cholesterol), sodium and they are rich in potassium, fibre, folic acid

and vitamin C naturally. They also contain calcium, iron, sulphur and potash (Sobukola *et al*., 2007).

Vegetable and fruit waste is one of the major food waste generated in industrial regions with almost 50% of the waste from household. It leads to heavy disposal and environmental problem but it can be reused and recycled into a manure. Fruits waste are rich in carbohydrates content and other basic nutrients that support microbial growth. A total of about 50 million tonnes per annum of waste from fruits and vegetables was generated according to 2004 India Agriculture Research Data Book (Uchakalwar and Chandak, 2014).

Large amount of vegetable wastes from markets and kitchen create an unpleasant odour which leads to damaging the soil characteristics. The wastes are collected from markets through the municipality and dumped as landfills or leacheate that is highly affect the environment. However, it is not a plausible option for disposal of vegetable waste due to its high water content that are responsible for microbiological instability and formation of bad odour (Zhang *et al.*, 2007).

Composting is a biological decomposition process that breaks down organic material into a stable, humus-like substance. Composting increases the soil's ability to store water and reduces soil erosion. Additionally, recycling biowaste will help to lessen environmental degradation brought on by collected biowaste (Kumar, 2005). Composting is a safe method for the disposal and recycling of organic waste by converting to organic fertilizer.

Research is needed towards the acceleration of composting process, the better quality of compost, ascertaining the use of additives and finding cost-effective as well as efficient compost (Kumar, 2011; Lim *et al*., 2016). Organic manure is a method of crop production that can be used to increase soil fertility, main nutrients, microbial biomass, as well as for public health and environmental safety (Dhull *et al*., 2004).

Composting incorporates distinctive stage, the primary stage (mesophilic stage), is energy-rich effectively degradable compounds such as sugars and proteins are debased by organisms, actinobacteria and bacteria. The thermophilic phase, which is crucial for the eradication of pathogens and parasites and maintains the highest level of sanitary conditions, enters into existence when the temperature rises above 450^{o}C. When the microorganisms' activity declines as a result of the substrate's depletion, the temperature begins to drop, which triggers the cooling phase, also known as the mesophilic phase. The mesophilic

microorganisms such as microscopic organisms, parasites and actinomycetes starts to develop once more and prevail amid these stage and development stage. Within the development stage, the compost heap is stabilized for plant utilize and the extent for parasites increments whereas bacterial numbers decline (Ho *et al*. 2022).

Vermicomposting is a low-cost technological process of composting where earthworm species were introduced into the compost to generate a better end product. Application of vermicompost in the soil promotes the growth of the plant and helps in protecting the crops from pest and disease. Vermicompost also increases microbial population in the soil and improves soil fertility which improves agronomic and horticulture crop yield (Sinha *et al*., 2010).

Chemical fertilizer may apply to increase the yield of the crop for a short duration but it will also affect the soil fertility, soil degradation and deteriorate the environment. The nutrient content of the vermicompost is much higher. The complex materials in organic waste are transformed into simple, water-soluble compounds by earthworms (Datar *et al.,* 1997).

Vermicomposting are in same line with the principle of a healthy environment due to its value of resource conservation and sustainable practices, as a process for handling organic residue which is an alternative approach in waste management, which is not dumped or eradicated but can be reuse for sustainable environment (Aalok *et al.,* 2008). Vermicompost improves soil structure, soil moisture holding capacity, vegetative growth and enhances crop yield.

Biodegradation of wastes by mushroom spawn such as *Pleurotus eous* (APK1), *Trichoderma asperelloides* and earthworm (*Eudrilus eugeniae*) are safe and effective eco-friendly process and at the end of composting, the waste is converted to black mass of manure. *Pleurotus* and *Trichoderma* play an important role in helping the degradation of organic matters. Pandya and Saraf, (2010) reported that *Trichoderma* species act as an important biocontrol agent against phytopathogenic fungi and also play a vital role in biological decomposition of the waste quickly without emitting foul smell.

Trichoderma asperelloides also known as *Trichoderma viride* reportedly produce ligninolytic enzyme that help in reducing the lignin content. Hence, the use of *Trichoderma* based composting technologies are widely accepted and enhance decomposition (Ghorbani *et al.*, 2015). Fungus *Trichoderma* sp. is used to accelerate the decomposition of organic

matter and can produce chitinase enzyme that play an important role in the control of pathogenic plants in microparasitism (Nusaibah and Musa, 2019).

Pleurotus species are commonly known as pink oyster mushroom, abalone or tree mushroom belonging to class *Basidiomycetes* and it has been reported to improve the soil nutritional status, management of various plant disease and capable of producing compost with higher nutrient content. *Pleurotus eous* spent compost can be used as soil conditioner for the enhancement of plant growth (Wiafe-Kwagyan and Odamtten, 2018).

The earthworm *Eudrilus eugeniae* Kinberg commonly known as 'African night crawler' a native to tropical west Africa. Earthworm is classified into three groups viz. epigeic, anecic and endogeic. The selected earthworm species *Eudrilus eugeniae* belong to epigeic which dwell on the surface and it have a greater potential for degrading the organic wastes.

Earthworm are used as agent during vermicomposting process around the world. The role of earthworm in the ecosystem includes nutrient recycling and it also affect the physico chemical characteristic of the soil positively. Microbial flora plays an important role during vermicomposting directly or indirectly. The earthworm feed on organic matter which is digested in their gut with help of enzymes and excrete an efficient black colour casting manure (vermicompost). Earthworm secrete mucus and fluids which maintain the pH of the soil microflora. Vermicompost has a sweet and earthly smell like smell of first rain which is due to actinomycetes and there is no malodour associated with traditional composting (Kadam, 2004).

The beneficial effect of vermicompost on various plant growth, productivity and physicochemical characteristic were studied in green house as well as under field experiment. Vermicompost changes the composition of humic substances qualitatively and quantitatively (Arancon *et al.*, 2004; Gutierrez-Miceli *et al.*, 2007).

Legumes are staple nutritious food all over the world. Fabaceae or Leguminosae family is the third largest flowering plants consisting of over 20,000 species. Legumes are competitive crops due to their environmental and socio-economic benefits. Legumes fix the atmospheric nitrogen with the help of root nodules which release into the soil to maintain high quality organic matter, facilitate soil nutrients circulation and water retention capacity (Stagnari *et al.*, 2017). Legumes serve a variety of purposes and have a significant potential

for use in traditional agriculture, both as a crop and as a byproduct. The nodules are the storehouse of microscopic rhizobium that convert atmospheric nitrogen to nitrate and ammonia that can be used by the plant.

Leghaemoglobin is oxygen carrier and monomeric hemoprotein synthesized in the root nodules of leguminous plants and play a vital role in nitrogen fixation process by providing oxygen to the bacteria for respiration (Singh and Vijayalakshmi, 2016; Oldroyd *et al.*, 2011).

Following grains and oilseeds, pulses form a significant component of Indian agriculture. The majority of vegetarians' dietary protein comes from pulses, which account for 14% of the average Indian diet's total protein intake. Pulses are eaten as part or entirely and the part grain is called dahl which have an fabulous source of protein, fundamental amino acids, greasy acids, filaments, minerals and vitamins. Pulses offer assistance in moving forward the soil wellbeing by enhancing nitrogen status, long term richness and feasible trimming framework (Mahilane *et al.*, 2017; Choudhary *et al.*, 2017).

Black gram [*Vigna mungo* (L.) Hepper] (Plate 1A, 2A) also known as urd or urad dal in Hindi, Ulutham Paruppu in Tamil belong to a family Fabaceae. India is the world largest producer as well as consumer of Black gram and the third most important pulse, where beans are eaten wholly or in split, boiled or roasted, ground flour are used as major ingredients for different kind of food such as cakes and biscuits. Black gram produces about 1.5–1.9 million tons annually from about 3.5 million hectares of area, with an average productivity of 600 kg ha^{-1} (Marimuthu and Surendran, 2015). Approximately 10% of India's total pulse production is black gram (MoA, 2012).

Black gram is herbaceous with erect fast-growing legumes reaching upto 30-100 cm in height and well branched. It is an annual pulse crop native to central Asia grown mainly in South and South east Asian countries including Afghanistan, Bangladesh, India, Pakistan, Nepal, Myanmar, the Philippines, Sri-Lanka and Thailand (Kaewwongwal *et al.*, 2015). It has tap root system while the leaves and stem were covered with rough reddish hair and slightly ridged. Leaves are large and trifoliate. The leaflet is 5-10 cm long, broad, ovate and entire, the flowers are complete, self-pollinated, yellow in colour, auxiliary racemose and pods are cylindrical and 4-6 cm long.

PLATE - 1

Habit of plant grown in winter compost

PLATE - 1A Black gram [*Vigna mungo* (L.) Hepper] Var. Co 6

PLATE - 1B Lablab [*Lablab purpureus* (L.) Sweet] Var. Co (Gb) 14

Black gram is a nutritious pulse that is a good source of calcium, potassium, iron, magnesium, copper, and manganese. It is also high in vitamins and minerals. Black gram has a 25% protein, 56% carbohydrate, 2% fat, 4% mineral, and 0.4% vitamin content. Asian nations also consume sprouts as veggies.

Lablab [*Lablab purpureus* (L.) Sweet] (Plate 1B, 2B) is an annual, herbaceous, twining or climbing and branching plant growing upto the height of 3-6 metre and leaves are trifoliate and alternate. It is commonly known as lablab or Hyacinth bean or Indian butter bean or broad bean in English, Avarakai in Tamil, Avara in Malyalam belonging to family Fabaceae. It can be found all throughout Asia, Africa, and America in both the tropical and temperate climates. A versatile legume, lablab is primarily planted as a garden crop, yet the green, soft entire pods can also be eaten as a vegetable. It produces white, green, or purple marginal pods with different-colored seeds, including white, yellow, brownish, purple, and black seeds (Vaijayanthi and Ramesh, 2019). After *Solanum melongena* and *Colocasia* spp., Lablab is the third-most significant vegetable in Bangladesh's central and western regions, with a total production area of about 48,000 hectares (Rashid *et al*., 2007). An archaeobotanical finder in India discovered the ancient crop lablab prior to 1500 BC (Fuller, 2003).

It produces a twining stem that can be 6 - 9 metres long. The plant is best known for its edible seed and for its wide range of medicinal applications. It can also be used as a green manure. An N-fixing legume called lablab can be used in cereal farming systems. It can successfully suppress soil fertility. Soil fertility refers to quality of a soil that have an ability to provide nutrient in adequate or balance amount for the growth of the plants. For carbon, nitrogen, phosphorus, and sulphur, soil organic matter is a significant terrestrial source. Microbial immobilisation and mineralization continuously alter the availability and cycle of these elements (Feichlinger *et al*., 2004).

Soil is habitat for variety of microorganism, animal and plant roots. Soil microorganism play an important role in soil fertility due to their influence as a source of minerals nutrient. A soil that enable deep rooting, provides proper aeration, has good water holding capacity with adequate and balance supply of plant nutrients are considered favourable for plant growth and initiate soil fertility. There are about 16 elements having one or more special function for plant growth and development. Nitrogen, Phosphorus and Potassium are the most importance nutrient required for plant growth (REAP- Canada, 2003).

PLATE – 2

Habit of plant grown in summer compost

PLATE - 2A Black gram [*Vigna mungo* (L.) Hepper] Var. Co 6

PLATE - 2B Lablab [*Lablab purpureus* (L.) Sweet] Var. Co (Gb) 14

The soil enzyme derived from soil fungi, bacteria, plant roots, microbial cells, plant and animal residues mediates the biochemical transformation that involved the decomposition of organic residue and nutrient cycle in soil.

Antioxidant and antibacterial activity study have been carried out by various researcher in crops as well as medicinal plants and it also represent as a important parameter to ensure the quality of functional foods on human health and affect the shelf life of the product. Many investigations reveal that antioxidant and antibacterial profile in *Capsicum annum* (Aminifard *et al.*, 2013), Tomatoes (Borguini *et al.*, 2013), *Moringa oleifera* (Das *et al.*, 2022), *Manihot esculenta* (Nur *et al.*, 2013), *Solanum nigrum* (Mary and Nithiya, 2015), *Labisia pumila* Benth (Ibrahim *et al.*, 2013) using organic and inorganic compost.

Organic farming is the biodegradation of organic matter to produce eco-friendly compost or manure. Organic farming is important since it reduces the use of fertilizers and pesticides. The principles of organic farming express the contribution that can make the world and a vision to improve agriculture in a global context. It helps in improving the quality of crops, reduces environmental pollution and also brighten the export of organic food.

The outcome of the study is to collect the waste, recycled and produce the most economical manure and also encourage to minimize the use of chemical fertilizers. Hence, the present study was conducted to study the effect of vegetable and fruit waste biocompost on the vegetative, biochemical, yield, leghaemoglobin, antioxidant and antibacterial activities on Black gram [*Vigna mungo* (L.) Hepper] and Lablab [*Lablab purpureus* (L.) Sweet] grown in organic compost of two seasons viz. summer and winter.

Objectives of the studies:

- To prepare compost from vegetable and fruit wastes using fungus such as *Pleurotus eous* (APK1), *Trichoderma asperelloides* and earthworm (*Eudrilus eugeniae*).
- To carry out Summer (May-July) and Winter (November-January) composting.
- To count the microbial population in biocompost on 30^{th}, 60^{th} and 90^{th} days.
- To analyse the FT-IR and physico-chemical composition of raw and composted Vegetable and Fruit wastes.

- To study the influence of biocompost as manure on the growth and yield of Black gram [*Vigna mungo* (L.) Hepper] Var. Co 6 and Lablab [*Lablab purpureus* (L.) Sweet] Var. Co (Gb) 14
- To analyse the leghaemoglobin content in the nodules of Black gram and Lablab.
- To estimate the chlorophyll content in leaves of selected plants.
- To estimate the protein, carbohydrate and crude protein content in leaves and seed of selected plants.
- To study the antioxidants and antibacterial activity of winter and summer composted. Black gram and Lablab grown under best treatment and Control treatment.
- To analyze the pre and post harvested soil.