CHAPTER – 1

GENERAL INTRODUCTION

The *agriculture* development strategy for India in the 21\textsuperscript{st} century must be through increasing productivity of the land under cultivation, with reduced costs of production and higher use efficiency of inputs with no harm to the environmental quality. The prime requisite is the promotion of health of the soil-plant-environment system to be free from economic exploitation under overuse and abuse of the input as if with impunity (Ayala and Prakasa Rao, 2002). No doubt, the use of chemical fertilizers was boon for the past but ban for the present. Now it is time to reanalyze the technological development on the cost of nature destruction. Several mammoth problems related to soil structure and productivity is the results of fossil fuel based energy inputs in intensive cultivations. Changes in the soil pH, soil acidifications and lower humic acid contents are some key problems of overuse of synthetic fertilizers.

The poor soil respiration rate and complete vanishing of natural decomposer communities from agroecosystems has questioned the land sustainability and future food security (Suthar, 2008a). Similarly, the escalation in the cost of chemical fertilizers, particularly that of N, coupled with concerns about pollution have focused attention on the use of combined application of nutrients through organic and inorganic source in crop production. Therefore, nutrient supply in crop system should be economically viable, environmental friendly and socially acceptable without affecting the gross plant production. It has been realized that soil fertility can be managed in complete harmony with sustainable agriculture development by careful analysis of current issues of sustainable land productivity (Saleh, 2008; Srinivasarao *et al.*, 2008, Sipolo 2010).
The organic manure is an eco-friendly, economically viable and ecologically sound that also played a significant role in soil biology, chemistry and physics (Tiwari 1993). It is interesting that each year, human, livestock and crops produce approximately 38 billions metric tons of organic waste worldwide, which may be an efficient source of organic matter supply in soils. According to a conservative estimation, around 600 to 700 million tones (mt) of agricultural waste (including 272 million tones of crop residues) are available in India every year, but most of it remains unutilized. This huge quantity of wastes can be converted into nutrient rich bio-fertilizer (vermicompost) for sustainable land restoration practices (Suthar, 2008b., Tinn et.al. 1995).

Vermiculture is the science of rearing of earthworms for mass propagation on organic wastes under semi-natural conditions and vermicomposting is the bioconversion of organic waste materials through earthwormic way (Senapati, 1992). Sensi et al. (1996) (manna et ai 1997) mentioned that vermicomposting is a controlled, aerobic, biological process and able to convert biodegradable humus like organic substances and suitable for the application of soil amendment.

In general, a great proportion of the crop nutrient input during cultivation returned in the form of the plant residues. Estimation showed that 30-35 % of applied N & P and 70-80 % for K remained in the crop residues of food crops. Such nutrient rich crop residues must be ‘prepared’ before they are used as a fertilizer, and earthworms are suitable candidates for the same (Suthar, 2007). The earthworm-processed organic wastes, often referred to as vermicomposts, are finely divided peat-like materials with high porosity, aeration, drainage, and water holding capacity (Edwards and Burrows,1988). The vermicomposting is biooxidation and stabilization
of organic material involving the joint action of earthworms and microorganisms. Although, microbes are responsible for the biochemical degradation of the organic matter, earthworms are the important drivers of the process, conditioning the substrate and altering biological activity (Aira et al., 2002; Suthar, 2008b; Garg et al. 2011).

Several studies have revealed that vermicompost may be potential sources of nutrients for field crops if applied in suitable ratios with synthetic fertilizers. Also, vermicompost may contain some plant growth-stimulating substances. Several workers have reported a positive effect of vermicompost application on growth and productivity of cereals and legumes (Benik and Bhebaruah, 2004; Suthar, 2006), ornamental and flowering plants (Kale et al., 1998a, 1998b; Nethra et al., 1999), vegetables (Edwards and Burrows; 1988; Atiyeh et al., 2000) etc. Atiyeh et al. (2001) concluded that vermicomposts, whether used as soil additives or as components of greenhouse bedding plant container media, have improved seed germination, enhanced seedling growth and development and increased overall plant productivity. (Maynard -1995)

Vermicomposting is a mesophilic process and the process of ingestion, digestion, and absorption of organic waste carried out by earthworms followed by excretion of castings through the worm’s metabolic system (Springett 1984). During their biological activities the levels of plant-nutrients of organic waste are enhanced. During the process, the nutrients locked up in the organic waste are changed to simple and more readily available and absorbable forms such as nitrate or ammonium nitrogen, exchangeable phosphorus and soluble potassium, calcium, magnesium in worm’s gut. Vermicompost is often considered a supplement to fertilizers and it
Vermicomposting is one way of enriching the soil physicochemical properties. (Vasanthis et al., 2011) Earthworms speed up the composting process, aerate the organic material and enhance the finished compost with nutrients and enzymes from their digestive tracts. The effective use of the earthworms in organic waste management requires a detailed understanding of the effect of the physicochemical properties of the substrate. (Macdonald et al., 1981)

Researchers have identified and named more than 4400 distinct species of earthworm, each with unique physical and behavioral characteristics that distinguish them one from the other. These species have been grouped into three categories, endogeic, anecic and epigeic, descriptive of the area of the natural soil environment in which they are found and defined to some degree by environmental requirements and behaviours. Epigeic earthworms do not inhabit the soil rather they live in and consume surface litter (Rushman, 1953). These worms are domesticated and, when fed plant and animal wastes, they produce vermicompost, a process that has many advantages over conventional composting. This technology serves both social and environmental goals of sustainable agriculture and is widely employed in India, Australia, New Zealand, Cuba and Italy but seldom in Africa.

Epigeic earthworms do not burrow into the soil and are therefore more easily contained within vermicomposting systems than other types of earthworms. Epigeic earthworms can be raised at several levels of production, from backyard bins to large-scale composting of agricultural, municipal and industrial biosolids. Epigeic earthworms fragment organic matter and provide microenvironments for the
establishment of decomposing microorganisms. The next two types are the anecics and Endogies which lives inside the soil. They are of burrowing types and the are also recommended for Vermicomposting in some areas.

Interestingly, earthworm activity is closely associated with microbial activity. Lavelle (1992) is of the opinion that there may exist competition between microorganisms and earthworms for easily digestible and energy rich substrates. Such competition may depend on availability of nutrients in the medium. Contrary to this, earthworms may derive benefit from microorganisms when they have to survive on materials rich in cellulose or hemi cellulose. So there exists mutualistic relation between earthworms and microorganisms. Tiunov and Scheu (2004) have shown that earthworms deprive easily available carbon to microorganisms and availability of carbon increases effective mobilization of N and P by earthworms. The complex interrelationship of earthworms and microorganisms is at the level of their digestive tract, castings, and burrow walls Edwards and Arancon (2004). This establishes the probable mutualism that exists between earthworms and microorganisms. Bhat et al. 1960 were the pioneer contributors to report on role of microorganisms in the gut of earthworms. Khambata and Bhat (1957) had made a detailed investigation on intestinal microflora of Pheretima sp. They had isolated Pseudomonas, Corenyform bacteria, Nocardia, Streptomyces, and Bacillus from the intestinal tract. The vermicasts of P. ceylanensis showed 14 different fungal species belonging to the genera, Aspergillus, Chaetomium, Cladosporium, Cunninghamella, Fusarium, Mucor, Penicillium, and Rhizopus (Karmegam and Daniel 2000).

Earthworms also successfully decomposed sugar factory residuals and turned them into a soil nutrient that allowed farmers using the material to reduce chemical
fertilizer by 50% (Logsdon, 1994). Vermicasts are believed to contain enzymes and hormones that stimulate plant growth and discourage pathogens (Ismail, 1997; Abbasi and Ramasamy, 1999; Szczeck, 1999). Vermicompost added to various container media significantly inhibited the infection of tomato plants by *Fusarium oxysporium* sp the protective effect increased in proportion to the rate of application of vermicompost (Szczeck, 1999). Whereas vermicast generated from animal dung is universally believed to be beneficial to soil plants, there are no reports giving evidence that the same may be true of vermicasts generated from other sources. To explore this area, several authors have conducted three studies on the impact of the application of water hyacinth and neem compost on plants (Gajalakshmi and Abbasi, 2002; Gajalakshmi and Abbasi, 2004a; Satchell, 1996; Bhawalker, 1996). Deolalikar and Mitra (1997) have used vermicompost prepared from paper mill solid waste for fertilizing aquaculture tanks and found an increase in net primary productivity from 32.08 to 220.83 mg C/m/h. Vermicompost application also showed better growth of Rohu fish (*Labeo rohita*) when compared with other commercially available organic manures (Deolalikar and Mitra, 1997).

Now-a-days gradual deficiencies in soil organic matter and reduced yield of crop are alarming problem in India (Basker *et al.*, 1993). The cost of inorganic fertilizers is very high and sometimes it is not available in the market for which the farmers fail to apply the inorganic fertilizers to the crop field in optimum time. On the other hand, the organic manure is easily available to the farmers and its cost is low compared to that of inorganic fertilizers. The crop production cost is more or less similar with organic and inorganic fertilizer (Haque, 2000), the use of readily available organic sources of nutrients should be used to maximize the economic return.
Use of vermicompost for vegetable production in large scale can solve the problem for disposal of wastes and also solve the lack of organic matter (Abbot et al 1981). On the other hand, a judicious combination of organic and inorganic sources of nutrients might be helpful to obtain a good economic return with good soil health for the subsequent crop. Application of vermicompost increases the total microbial population of N-fixing bacteria and actinomycetes. The increased microbial activity improves the availability of soil phosphorous and nitrogen.

Vermicomposts from these wastes promote growth of crops when added to the soil and compare favorably with greenhouse potting mixtures for production of seedlings and flowering plants (Edwards, 1988). There is a need, however, to bridge the gap between controlled vermicomposting within the laboratory and the broader field utilization of vermicomposts in organic resource management.

1.1. STATEMENT OF THE PROBLEM

Growing concerns related to land degradation, the inappropriate use of inorganic fertilizers, atmospheric pollution, soil health, soil biodiversity and sanitation have rekindled global interest in organic recycling practices such as vermicomposting. The potential of vermicomposting to turn on-farm waste materials into a farm resource makes it an attractive proposition. Vermicomposting offers benefits such as enhanced soil fertility and soil health. However, many farmers, and especially those in developing countries find themselves as a disadvantage as they fail to make the best use of organic recycling opportunities using earthworm. Thus, Vermicomposting could be one of the valuable options for Indian farmers to restore or enhance their agricultural soil physical, chemical and biological properties.
1.2. PURPOSE OF THE STUDY

In spite of a range of significance of vermicompost, the variation of same chemical properties of vermicompost caused by substrata and worms used, being an important parameter has not received due attention of the investigators in India. In view of this gap in knowledge, this study is particularly carried out to evaluate the nutritional status of two different vermicompost, variation of effect of Vermiwash and their microbial status and finally field application of vermicompost into paddy.

1.3. OBJECTIVES OF THE PRESENT STUDY

1. The focus of this study was to investigate and compare the two different vermicomposting amended with *Teprosia purpurea* (Koolinji), *Cassia auriculata* (Avarai) leaves and cow dung, by using two earth worm species, *Eisenia fetida* and *Eudrilus eugeniae*.

2. To evaluate the impact of different types of vermicompost on growth and yield of a popular crop of tropics i.e. *Oryza sativa* under field conditions.

3. To determine the quality of the vermicompost produced from different organic wastes by microbial analysis.

4. To evaluate chemical and microbiological composition of vermiwash for field application and sustainable agricultural practices.