1. INTRODUCTION

India is facing intense problem of population outburst. People are experiencing the crisis such as shortage of food, climate change and also severe energy crisis due to increasing population. This increased population will require about 240 million tonnes of grain per year. In order to produce such an enormous amount of food grain, India would require extra land for cultivation which is beyond our scope as it would surely cause environmental pollution and deforestation. The only alternative at present is to improve the already existing crop varieties to yield more. Therefore there is a necessity to increase crop production is inevitable one (Sandip, 2011).

The nutrition of the plant is one of the most important factors to control agricultural productivity. Continuous agricultural practices diminish the nutrient content of the soil. Soil is the main source of supplying essential elements to plants. There are sixteen elements which are necessary for plants. They are: Carbon, Hydrogen, Oxygen, Nitrogen, Phosphorous, Potassium, Calcium, Magnesium, Sulphur, Iron, Manganese, Boron, Zinc, Copper, Molybdenum and Chloride (Ann McCauley, 2009). Out of these sixteen nutrient elements required by plants, Carbon and Oxygen are supplied by air, Hydrogen is supplied by water and remaining thirteen elements are supplied by soil. Six of these elements are required in larger amounts. They are called macro nutrients. The elements categorized as macro nutrients are: Nitrogen (N), Phosphorous (P), Potassium (K), Calcium (Ca), Magnesium (Mg) and Sulphur (S). The remaining seven elements required in trace or micro amounts are called micro nutrients. They are: Iron (Fe),
Manganese (Mn), Boron (B), Zinc (Zn), Copper (Cu), Molybdenum (Mo) and Chloride (Cl) (Steven C. Hodges, 1995).

These macro and micro nutrients are required by the plants and they are acquired from soil. When a particular mineral or a group of minerals are absent in the soil, the plant will show deficiency symptoms and affect the physiological processes in plants including reproduction and growth. To overcome the mineral deficiency and to increase the yield, the soil can be enriched by supplying these nutrients from external sources. The major compounds which are added into the soil to improve its fertility are grouped under two broad categories: (a) Chemical fertilizers and (b) Organic fertilizers. Most of the farmers fertilize the soil by adding Chemical fertilizers due to their quick action in soil (Ann McCauley, 2009).

Chemical fertilizers are commercially produced synthetic chemical substances added to the soil to overcome the deficiency of mineral nutrients and to maintain the fertility of soil. They enhance the vegetative growth (leaves, stem branches and roots) to make the plants healthy (Prasad, 2012).

Chemical fertilizers application increases efficiency and obtains better quality of product recovery in agricultural activities. Non-organic fertilizers mainly contain phosphate, nitrate, ammonium and potassium salts. Fertilizer manufacturing industry is considered to be a potential source of natural radionuclides and heavy metals. Fertilizers contains a large majority of the heavy metals like Mercury (Hg), Cadmium (Cd), Arsenic (As), Lead (Pb), Copper (Cu) and Nickel (Ni); natural radionuclide like Uranium ($^{238}\text{U}$), Thorium ($^{232}\text{Th}$), and Polonium ($^{210}\text{Po}$) (FAO, 2009; Sönmez et al., 2007).
Fertilizers may affect the accumulation of heavy metals in soil and plant system. Thus, fertilization leads to water, soil and air pollution. Plants absorb the fertilizers through the soil; they can enter the food chain and lead to bioaccumulation of fertilizer residue in food chain (Rena, 2004). The amount of nitrates and phosphates may increase in drinking water and rivers as a result of the transport of nitrogen and phosphorous fertilizer which were leached from agricultural land. Agricultural soil with high usage of nitrogen fertilizers consists of carcinogenic substances such as nitrosamines (Çevre ve Orman, 2004). Synthetic nitrogen fertilizers are nitrate salts. Nitrate salts dehydrate their surroundings. They are also very strong oxidizers, literally burning up the organic matter in the soil. These attributes are not a problem in natural ecosystems where nitrates are made available only as quickly as they can be consumed, but become a serious detriment when excess nitrates are applied (Wheeler and Ward, 1998).

Ammonium nitrate (NH₄NO₃) fertilizer in the soil breaks down into ammonium (NH₄⁺) and nitrate (NO₃⁻). The ammonium is consumed by plants and fungi or by bacteria which eventually convert it into nitrates, these nitrates are consumed by soil organisms, leached or converted to nitrogen gas and volatilized. The free oxygen created through this process oxidizes the organic matter of soil, these chemical reactions thus deplete the organic matter (Wheeler and Ward, 1998). Urea (NH₂CONH₂) is applied into the soil, it change the soil pH into alkaline and creates a toxic zone in the immediate vicinity of the applied area. The microorganisms and soil fauna around this toxic zone will die (http://en.wikipedia.org/wiki/Urease).
The application of chemical fertilizers inadequate to the soil it lessen the rates of productivity and quality of crops. When it is too much applied to soil, it causes chemical residues in food, soil degradation, and health risks to farm workers, so all of which bring into question the sustainability of the conventional farming system. Chemical fertilizers enhance the crop yield on one hand whereas on the other hand act as environmental hazards. Therefore, these chemical substances must be applied with utmost precautions. The left over residue of these chemicals lead to water pollution. They destroy the fertility of soil, if used continuously at a place, because the organic matter in the soil is not replenished. Moreover, the microorganisms present in the soil get harmed by constant use of chemical fertilizers. Therefore alternative methods of agricultural practice must be considered. Under present conditions, application of organic farming is much promising (Matson et al., 1997; Drinkwater et al., 1998; Tillman 1999; Zhu et al., 2000; Reganold et al., 2001; Xie et al., 2003).

Organic farming system is a method of farming system which primarily aims at cultivating the land and raising crops in such a way as to keep the soil alive and in good health by use of organic waste and other biological materials. Organic agriculture will increase the crop production and makes an eco friendly pollution free environment. The key characteristics of organic farming include: (a) protecting the long term fertility of soil by maintaining organic matter levels, encouraging soil microbial activity and (b) crop production with the use of alternative sources of nutrients such as crop rotation, residue management, organic manures and biocomposts (Ramesh et al., 2005).
Composting is an environment friendly method for treating of solid organic waste. Composting converts the active organic portion of solid waste into a stabilized product which can be used as a nutrient source for plant growth and/or as a conditioner to improve physical properties of soil. It can improve soil structure, increase soil organic matter and enhance plant growth. Compost is a rich source of organic matter. It improves the physicochemical and microbial activities of the soil. As a result of these improvements in the soil: (a) crop becomes more resistant to stresses such as drought, diseases and toxicity; (b) helps the crop in improved uptake of plant nutrients; and (c) possesses an active nutrient cycling capacity through vigorous microbial activity (Ramesh et al., 2005).

The main advantages of composting process are (a) composting reduces volume of the organic waste; (b) temperature rises while composting that kills pathogens, weed seeds and seeds; (c) reduces soil bulk density and improves the soil structure; (d) increases the water holding capacity of the soil directly by binding water to organic matter and thus pave way for improving the absorption and movement of water into the soil. Therefore, water requirement and irrigation will be reduced; (e) compost acts as an excellent soil conditioner; (f) eliminates the need for chemical fertilizers and pesticides; (g) cost effectively remediate soils contaminated by hazardous waste; (h) provides cost savings of at least 50% over conventional soil, water and air pollution technologies where applicable. Fertilizers give short term benefits where as compost gives long term benefits (Mansoor, 2004). There are some weeds species which are largely available and can also be used as organic manures (Channappagoudar et al., 2007).
*Parthenium hysterophorus* L. is one of the worst weeds in the world. It has spread to almost every part of India (Rao, 1956; Kohli *et al*., 1996). It is also known as star weed, carrot weed, white cap and white top (‘mookkuththi poo’ in Tamil) etc. *Parthenium* is an aggressive colonizer of waste land, road sides, railway sides, water courses, cultivated fields and over grazed pastures (Wiesner *et al*., 2007). It is an aggressive annual weed well adapted to grow under wide range of soil habitats and reported to produce 20,000 seeds per plant per year. (Butler, 1984). It does not allow other plants nearby to survive. *Parthenium* is known to badly affect crop production, biodiversity, animal husbandry, human health and even ecosystem integrity (Navie, 1996; Kohli and Batish, 1994; Adkins and Sowerby, 1996; Singh *et al*., 2003). It acts as a strong competitor for utilizing soil moisture and nutrients. (Narasimhan *et al*., 1977; Wiesner *et al*., 2007).

*Parthenium* causes general illness, asthmatic problems, irritations of skin and pustules on hand balls, stretching and cracking of skin and stomach pains in humans. It poses serious health hazards to both human beings and livestock and leads to an adverse impact on agricultural productivity (Wiesner *et al*., 2007). It is one of the noxious weeds threatening crop production in India. The rapid spread of *Parthenium* in India would be a bigger risk to the expansion and sustainable production of many crops. Control of *Parthenium* is therefore crucial to boost productivity of many crops in the country (Mew *et al*., 1982; Sharma and Bhutani, 1988; Sarita *et al*., 2011).

*Parthenium* is considered a noxious weed because of its allelopathic effect (Kohli *et al*., 2006). It is known to have allelopathic inhibitory effect on germination and growth
of crops (Kanchan and Jayachandra, 1980a, b; Kumari and Kohli, 1987; Kohli and Batish, 1994; Kohli et al., 1996; Tefera, 2002; Singh et al., 2003; Batish et al., 2005a; Batish et al., 2005b; Wakjira et al., 2005; Wakjira, 2009; Naeem et al., 2012). The allelochemicals released from Parthenium that affect many plant species (Swaminathan et al., 1990). Parthenin is a major allelochemical present in Parthenium weed (Kanchan and Jayachandra, 1980b; Singh et al., 2002; Batish et al., 2007). This allelochemical significantly decrease the seed germination and subsequent growth in many crops (Batish et al., 2005a, b; Singh et al., 2003). The only option that minimizes its allelopathic effect is its utilizing as compost (Belz et al., 2009; Wakjira et al., 2009). In the above research it can be judged that composting of P. hysterophorus may reduce its allelopathic potential.

Parthenium composting experiments were conducted in India and it is reported to have high N, P and K (Son, 1995; Biradar et al., 2006). Channappagoudar et al., (2007) have reported that Parthenium composted pre flowering has higher N content (2.95%) compared to poultry manure (2.02%), vermicompost (1.21%) and FYM (0.54%). The effect of P. hysterophorus ash on germination of plumule and radicle length and biomass production of Phaseolus mungo has been reported (Munesh and Sanjay, 2010). Son (1995) and Biradar et al., (2006) have reported a high level of Nitrogen, Phosphorous and Potassium in Parthenium compost. Parthenium compost contains two times more Nitrogen, Phosphorous and Potassium than farm yard manure. (Kishor et al., 2010). It is therefore important to look for options that minimize its allelopathic effect so that it could be utilized as compost. Further, composting Parthenium with different plant materials with various ratios further reduces its allelopathic potential (Wakjira et al., 2009).
Composting *Parthenium* with other plant materials with less or no allelopathic potential reduces the amount of allelochemicals released into the soil and the corresponding allelopathic inhibition potential (Hong *et al*., 2003; Brennan and Smith, 2005; Reeves *et al*., 2005; Batish *et al*., 2006; Stoll *et al*., 2006; Adler and Chase, 2007; Price *et al*., 2008). *Parthenium* composting with locally available plant materials may reduce its allelopathic effect (Wakjira *et al*., 2009).

The genus *Croton* comprises well over 1300 species growing as trees, shrubs, and herbs in tropical and subtropical regions of both hemispheres. Its various species are reported to possess diverse medicinal properties. One of its species is *Croton sparsiflorus* Morong (syn. *C. bonplandianus*), which grows in Asia and South America (Salatino *et al*., 2007). *Croton sparsiflorus* Morong belongs to the plant family Euphorbiaceae. It is a small annual herb, growing up to a height of 1 to 2 feet with alternatively arranged lance shaped leaves of 3 to 5 cm length. This is one of the noxious weeds present throughout Tamil Nadu and Andhra Pradesh. *C. sparsiflorus* is a woody shrub growing in sandy clay soil in India and Pakistan (Radcliffe-Smith, 1986). This plant and its seeds have been reported to be rich in potassium. The oil from the seeds has been chemically examined and found to be rich in linolieic acid (Annada Prasad *et al*., 2012).

*Croton sparsiflorus* contains high amount of alkaloids, (Chatterjee *et al*., 1965; Bhakuni *et al*., 1970; Mehmood and Malik, 2011) diterpenes, (Sargent, 1982) nonapeptide, (Mehmood and Malik, 2010) and 1-O-methyl cis-inositol, 8 and amides (Mehmood *et al*., 2010). The qualitative analysis of the ash showed that it contained calcium, magnesium, sodium, potassium, carbonate, sulphate and silicate (Annada Prasad
et al., 2012). Literature regarding composting of the commonly available weed
*Chenopodium sparsiflorus* is sparse.

The nutrient value of weed compost alone is low compared with that of chemical
fertilizers, and the rate of nutrient release is slow so that it cannot usually meet the
nutrient requirement of crops in a short time, thus resulting in some nutrient deficiency
(http://www.agritech.tnau.ac.in). Therefore weeds must be co-composted with some other
biological material to enhance the nutrient content of the compost.

Sea food processing is very high in India. Seafood is divinely rich by virtue of its
high nutritional value. Export of processed sea food items given the good revenue for the
country. Seafood processing industry in India is contributing tones and tones of waste
materials and amongst them prawn shell waste contribute more than one lakh tones every
year (Philip and Nair, 2006). The discharge of these waste materials in to land would
cause a serious environmental problem (Sini et al., 2005). Moreover, the prawn shell
wastes contain high amount of nutrients and minerals. The efficient utilization of these
wastes yields high economic value (Zakaria et al., 1998). Large quantities of wastes are
generated in the processing of aqua foods from crustaceans, molluscs and fishes. These
materials contain appreciable amounts of nutrients to plants which may be useful in
cropping programs (MacLeod et al., 2006).

The Indian prawn, *Penaeus indicus*, is one of the major commercial prawn species
of the world. It inhabits the East coast of India, coasts of East Africa, Pakistan and
Bangladesh. *P. indicus* is non-burrowing, active at both day and night, and prefers a
sandy mud bottom. Adults are normally found at depths less than 30 m but have also
been caught from 90 m. The prawn mature and breed mostly in marine habitats and spend the juvenile and sub-adult stages of 30 to 120 mm total length (TL) in coastal estuaries, backwaters or lagoons (Flegel, 2006).

*Penaeus indicus* is an important sea food for export. As in the case of fishes, its meat deteriorates very fast. For the transportation of prawns to distant places, they are processed. If the distance is short, they are packed between layers of ice either entirely or after removing cephalothorax. For long time preservation, the entire prawn or those with shells removed are dried in the sun for several days. The discarded shell and cephalothorax are mainly composed of chitin-based nutrients. Most aqua food processing waste was disposed of in landfill sites or applied haphazardly to land (Swanson *et al.*, 1980; Murado *et al.*, 1994). However, land fill disposal and agricultural use of raw prawn shell wastes can be inefficient in terms of crop nutrients, can produce leachate detrimental to the environment, and can generate offensive odours (Mathur *et al.*, 1986).

The composting of prawn processing waste with wood waste contains low amount of Nitrogen availability (Kuo *et al.*, 1994, 1997; Jellum *et al.*, 1995) but high amount of Phosphorous (Kuo *et al.*, 1999). Land application of prawn shell waste is not as problematic in terms of offensive odours as meat processing waste. Stabilization via composting may be beneficial to minimize problems such as odour and phytotoxicity of the prawn shell wastes (Henry and Mellish, 2001). Fresh prawn shell waste contains high amount of plant nutrients compared with composted prawn shell waste. However, concentrations of potassium (K), copper (Cu), and manganese (Mn) were higher in composted prawn shell waste than in the fresh waste material (Henry and Mellish, 2001).
The shells of prawn and the nacreous layer of seashells contain chitin (Falini and Fermani, 2004). Many bacteria belonging to the genera Bacillus, Clostridium, Serratia, Streptomyces and Xanthomonas have the capability to degrade chitin (Evvyernie et al., 2001).

There are many products that utilize organic compounds from seafood waste. Chitin, a natural polymer found in crustaceans is currently being used in numerous medical applications such as bandages to prevent continuous bleeding or as a wound dressing, or to assist in controlling blood cholesterol (Rawls et al., 1991; van Genuchten et al., 1992; Beven et al., 1993). It is most commonly used as a commercial dietary supplement because of its fat absorbing capabilities (Biggar, 1976; Rawls et al., 1991). Additional studies conducted show that chitin extracted from prawn shell and its derivatives can be useful in environmental science, specifically for treating water and in agriculture as a plant fertilizer, plant growth enhancer and fungicide (Gist et al., 1990; Rawls et al., 1991; Li and Ghodrati, 1997; Bejat et al., 2000).

The fact that discarded prawn shell can be utilized in a broad spectrum of health, medical and environmental fields, leads to a better solution for proper disposal and prevention of excessive build up of seafood wastes. Residues from aqua food wastes dumped into landfills have created management and environmental problems related to water pollution (Leij et al., 1999; Vanderborght et al., 2001) so it may utilized as organic supplements for agricultural crops.

Groundnuts are the major oilseed of India. Annual production of Indian groundnuts and Indian groundnut oil are around 5–8 million and 1.5 million tons
respectively. Groundnut production is highly vulnerable to rainfall deviations and display huge fluctuation between years. The major producers of groundnuts are Gujarat (1–3.5 million tons), Tamil Nadu (1 million tons), Andhra Pradesh (1-2 million tons), Karnataka (0.5 million tons) and Maharashtra (0.5 million tons). India exported around 100,000 tons of groundnut oil in 2003–04 after four decades, as crop failed in Senegal and Argentina (http://www.agrocrops.com/groundnut-division.php). It is estimated that the consumption demand of groundnut by the end of 2020 will be 14 million tonnes in India, whereas the current production of our country is 8.4 million tonnes. Therefore to meet the extra required demand of 5.6 million tonnes, we have to increase production by 2.2% per year. At present increase in cultivable area is not possible and therefore only viable option left is to increase the productivity per unit area. Groundnut grown in November to March has very little scope to go for yield increase because most of this is from rainfed cultivation (http://www.agrocrops.com/groundnut-division.php).

Groundnut is an important oil seed crop grown under rainfed conditions. An ideal soil for groundnut production is well drained, light colored, loose and friable sandy loam, which facilitates peg penetration and pod development. Under rainfed conditions, the productivity is very low due to inadequate use of manures and fertilizers. Groundnut is a base loving oil seed crop and its demand for basic nutrient elements like Potassium and Calcium is substantial. Potassium plays a major role in metabolic process and seed yield, improves the quality of seed (Yeledhalli et al., 2007). The challenge of improving the productivity in rainfed areas can be addressed by efficient utilization of nutrients by crops or cropping systems (Acharya, 2002). The productivity of groundnut is low in India as
compared to other countries mainly due to rain dependency (85%), monoculture (60%) and cultivation on marginal soils of low fertility (Parvathi et al., 2013). Agricultural practices that add chemical fertilizers to improve soil fertility, leads to soil pollution and therefore application of biocompost is a promising alternative to improve soil fertility. The compost formed from a combination of *Parthenium* and cow dung enhanced the nutrient value and increased the percentage of germination of legume plant, *Arachis hypogaea* (ground nut). Percentage of germination, radicle and plumule lengths of *A. hypogaea* greatly increased in 60 days-old *Parthenium* compost (Rajiv et al., 2013).

A specific group of naturally occurring beneficial microorganisms with an amazing ability to revive, restore, and preserve and were named as Effective Microorganisms (EM). EM is applied to the compost heap to reduce troublesome odours and flies as well as improving the compost process and quality (Higa, 1993).

From the foregoing literature, it can be clearly understood that in order to manage the high amount of weeds and crustacean wastes and composting of these two would play a prime role that paves the way for sustainable development in agriculture.
OBJECTIVES

The main objective of this study is:

- To utilize and manage biowastes such as *Parthenium hysterophorus*, *Croton sparsiflorus* and the prawn, *Penaeus indicus* shell in an innovative manner and use as a plant growth enhancer.

- To prepare a compost mixture using biowastes like *P. hysterophorus*, *C. sparsiflorus*, cow dung and Prawn shell powder in different combinations and ratios. The Effective microorganisms also used to fasten the composting process.

- To evaluate physical parameters like pH, electrical conductivity, moisture and chemical parameters such as carbon, nitrogen, phosphorous, potassium, calcium, magnesium, sulphur, sodium, zinc, manganese, iron and copper content of the compost.

- To find out the heavy metal content of the different compost mixtures.

- To investigate the morphology of the compost mixture using Scanning Electron Microscopic method.

- To evaluate the compost quality and phytotoxicity by seed germination experiment using legume seed, *A. hypogaea* (groundnut).

- To find out the physical and chemical parameters of the soil before using for pot experiment.

- To measure the length of root at 20th day of pot experiment and find out the effective compost concentration to support the ground nut root growth.

- To analyze the physico-chemical and microbial parameters of the compost-added soil with the highest groundnut root growth rate.