2. Review of Literature

2.1 Seaweeds as fertilizers:-

Use of seaweeds is a common practice in coastal areas throughout the world. In India, it is used for coconut plantations especially in coastal Tamil Nadu and Kerala. The high amounts of water soluble potash, other minerals and trace elements present in seaweeds are readily absorbed by plants and they control deficiency diseases. The carbohydrates and other organic matter occurring in seaweeds alter the nature of soil and improve the moisture retaining capacity (Silas et al., 1986). A method for composting the seaweeds with cowdung has been described by Thivy (1958, 1960). In the field trials conducted at the Central Marine Fisheries Research Institute, *Hypnea* compost when applied to bhendi, induced 73% increase in yield compared to cowdung and wood ash. Good results were also achieved with brinjal, tapioca, clustered beans, gourds, *Amaranthus virdis*, lime, papaya and drumstick when treated with seaweed compost. Crotons and zinnias also grew well with seaweed treatment (Thivy, 1960). The nitrifiability of organic nitrogen from *Ulva lactuca* and drift seaweeds from Veraval was studied and found to be high compared to farmyard or a few organic manures (Mehta et al., 1967). According to these authors, seaweeds, especially the drift seaweed, which is a mixture of a variety of species cast ashore, can be promising supplementary organic manure. The results of seaweed manuorial trials on *Pennisetum typhoides* (plant millet) and *Arachis hypogea* (ground nut) are reported by Bokil et al., (1972). With a view to find out the effect of seaweed manure on the uptake of inorganic nutrients by the wheat
plant, a pot culture experiment was conducted (Bokil et al., 1974). Bhosle et al., (1975) studied the seaweed extract on the growth of *Phaseolus vulgaris*. Marine algal extracts obtained from *Spatoglossum asperum, Ulva fasciata* and *Enteromorpha intestinalis* were found to promote germination in seeds and growth of seedlings of gram, ground nut and maize (Bukhari and Untawale, 1978). The method of preparation and properties of liquid seaweed fertilizer from *Sargassum* was given by Sreenivasa Rao et al., (1979). The effect of seaweeds on the growth of tomato seedlings was studied by Rajeshwari et al., 1983. Dhargalkar and Untawale 1983 observed the effect of seaweed liquid fertilizer on higher plants. The impact of commercial seaweed extract on bean was assessed by Vijayalakshmi and Lakshmanan (1988).

The effect of crude and commercial seaweed extracts on seed germination and seedlings growth in green gram, black gram, Bengal gram and red gram was investigated by Venkataraman Kumar et al., 1993, Mohan and Venkataraman Kumar 1993, Venkataraman Kumar and Mohan 1994 and Mohan et al. 1994. Sekar et al., 1995 studied the effect of SLF on cowpea. The biofertilizer potential of the SLF was evaluated by observing 18 growth parameters (Venkataraman Kumar and Mohan, 1997). The effect of fresh extracts and seaweed liquid fertilizers on some cereals and millets was studied by Immanuel Rajkumar and Subramanian, 1999. The effect of SLF on *Vigna* and *Dolichos* has been reported by Anantharaj and Venkatesalu 2001, 2002. Effect of SLF on bhendi has been studied by Selvaraj et al., 2004.

The effect of liquid seaweed fertilizer extracted from *Gracilaria edulis, Sargassum wightii* and *Ulva lactuca* on the growth and yield of *Abelmoschus* has been
studied by Sylvia et al., 2005. Thirumal Thangam and Maria Victoria Rani, 2006 have studied the effect of SLF and photosynthetic pigment of *Sorghum bicolor*. The effect of *Ulva lactuca* crude extract on growth and biochemical characteristic in *Cyamopsis tetragaalola* has been investigated by Lingakumar et al., 2006. Ramamoorthy et al., 2006 have reported on vigour and viability in cowpea resulting from organic priming with Sargassum extract. Sivasankari et al., 2006 have studied the effect of seaweed extract on growth and yield of *Vigna sinensis*. Balakrishnan et al., (2007) studied the effect of crude seaweed extract on seedling growth and biochemical parameters in *Pennisetum*.

Aqueous seaweed sprays on the growth and yield of pigeon pea has been studied by Ramamoorthy and Sujatha, 2007a. Ramamoorthy et al., (2007) have reported on the utilization of seaweed extracts for enhancing yield in black gram. Sahaya Antony Xavier and Louis Jesudass, 2007 have studied the effect of seaweed extract on cluster bean. Renuka bai et al., 2008 have studied the effect of SLF on *Phaseolus*. Jothinayagi and Anbazhagan, 2009 have reported the effect of SLF from *Ulva lactuca* on *Abelmoschus esculentus*. Sethi and Adhikari, 2009 have investigated the effect of *Rhizobium* in combination with SLF on vegetative growth and yield of *Arachis hypogea* and *Vigna mungo*. The effect of commercial fertilizer and LSF of *Enteromorpha intestinalis* on the growth of *Capsicum annum* has been determined by Veeragurunathan, 2009. Effect of soaking and foliar spray with seaweed extract in Bhendi has been studied by Vethanayagi et al., 2009 a, b.

The effect of the seaweed *Laurencia papiliose* extract on reducing and non-reducing sugar content in *Zea mays* has been studied by Sobithabai and Asir Selin.
Kumar, 2010. Delfin Chitra et al., 2010 have reported their study on the effect of the seaweed Hypnea musciformis extract on germination, growth and pigment changes in Vigna radiata. Studies on effect of Gracilaria varrucosa extract as liquid biofertilizer on Sesamum indicum have been carried out by Gandhimaniyan et al., 2010.

A comparative study on the effect of Ulva lactuca liquid fertilizer by different methods of extraction on Vigna radiata seedling was undertaken by Jeba Ananthi et al., 2010. Potentiality of Sargassum wightii as a fertilizer on black gram and yield by image analysis has been explored by Sivakumar and Gandhi, 2010.

Work on seaweeds as Fertilizer outside India

Booth (1969) observed that the value of seaweed as fertilizer was not only due to nitrogen, phosphorus and potash content but also because of the presence of trace elements and metabolites similar to plant growth regulators. Blunden et al., (1974) studied the effects of aqueous seaweed extract on sugar beet. Williams et al., 1974 reported the presence of gibberellin in the seaweed extract for a short time after preparation and of cytokinin over a longer period. Stephenson, 1974 confirmed that pasture treated with liquid seaweed extract contained a higher protein content at harvest time (3.8 to 5.0%) than pasture treated with the usual fertilizers. Blunden and Wildgoose, 1977 reported a significant increase in the yield of potatoes of the variety king Edwards by foliar application of an aqueous seaweed extract of known cytokinin activity. Liquid seaweed fertilizers are easily absorbed through roots and leaves, besides releasing trace elements bound to the soil (Chapman and Chapman, 1980). The effect of foliar applications of a commercially available seaweed concentrate (Kelpak 66) on the growth
of swiss chard plants (*Beta vulgaris* L.) was investigated by Featonby-Smith and Van Staden, 1983. Mooney and Van Staden, 1986 have reported that seaweed extracts increase crop yield, improve growth, induce resistance to frost, fungal and insect attack, reduce spider, aphid and nematode infestation, and increase nutrient uptake from soil.

Jeanin *et al.*, 1991 studied the effect of the seaweed extract, Goemar GA14, on biomass production, photosynthesis and photosynthate partitioning patterns in young maize plants. Blunden *et al.*, 1997 showed that aqueous extract of *Ascophyllum nodosum* applied as foliar spray enhanced leaf chlorophyll levels in tomato, dwarf French bean, wheat, barley and maize. The green seaweeds *Cladophora dalmatica, Enteromorpha intestinalis, Ulva lactuca*, the red algae, *Corallina mediterranea, Jania rubens* and *Pterocladia pinnata*, the most abundant algae occurring along the coast of Alexandria, Egypt were used to test the potential of their extracts on seed germination, growth and some metabolites in Faba beans (*Vicia faba*) by El-Sheikh and El-Saied, 1999. Two seaweed concentrates were made from the kelps *Ecklonia maxima* and *Macrocystis pyriformis* using a cell burst method. Cytokinin and auxin-like activities were measured using the soybean callus and mung bean bioassays respectively (Stirk *et al.*, 2004). The influence of alginate-derived oligosaccharide was tested on the maize seed germination at different concentrations (Hu *et al.*, 2004).

### 2.2. Seagrasses as fertilizers:

Research studies on the use of seagrasses which are marine angiosperm or flowering plants as fertilizers are gaining momentum. The influence of seagrass liquid fertilizer (SGLF) on cotyledon in *Cymopsis tetragonaloba* has been studied by
Sobithabai et al., 2008. Asir Selin Kumar et al., 2006 have studied the impact of SGLF on germination and growth in Zea mays. The impact of the seagrass Syringodium isoetifolium extract on the pigmentation in Abelmoschus esculentus has been assessed by Sobithabai et al., 2007.

Asir Selin Kumar, 2009 has studied the influence of seagrass Syringodium isoetifolium extract on germination and growth of Oryza sativa. Sobithabai et al., 2010 carried out studies on the impact of seagrass Syringodium isoetifolium extract on germination and linear growth of Sorghum bicolor. The impact of SGLF on photosynthetic pigments and chlorophyllase activity in Sorghum and Vigna has been assessed by Asir Selin Kumar and Sobitha Bai, 2010 and Femila Jose et al., 2010.

**Application of Seaweeds on stressed plants:**

Mooney and Staden 1985 studied the effect of the commercial seaweed concentrate Kelpak 66 on the field of winter wheat grown under conditions of water stress. Yvin, 1994 has reported the use of liquid seaweed extracts as growth stimulants, deficiency correctors and anti-stress agents. The effect of the commercial seaweed concentrate Kelpak on the growth and yield of wheat grown under nutrient stressed condition was investigated by Beckett and Van Staden, 1989. The impact of SLF on recovery of drought stressed black gram (Vigna mungo) and ragi (Eleuscin coracana) was studied by Venkataraman Kumar, 2000; 2003. Arunkumar et al., 2002 investigated the alleviating effect of SLF on the water stressed black gram.
So a thorough review of literature clearly revealed that the work pertaining to the effect of SLF on water stressed plants is meagre while that of SGLF is nil.

Hence the present research work was taken to study the effect of SLFs and SGLFs on water stressed plants. Prior to this, a standardization work was carried out to determine the most effective of the four methods adopted for extraction of SLF and SGLF. The SLF/SGLF thus obtained were employed for evaluation of their possible water stress alleviating potential.