Chapter IV

Summary and Conclusions

Seaweeds form an important marine bioresource that is exploited for their multifunctional properties such as food, feed, medicines, cosmetics, energy and many others. Seaweed manures are being used traditionally in agricultural practices as a source of organic matter to the soil. They contain a number of essential minerals, micronutrients and plant growth regulating substances. Algal vegetation along the western coast of Maharashtra is luxuriant during post monsoon period and also shows a rich biodiversity. Very few studies report the scientific application of seaweeds to crop plants and their influence on the growth. In the present work effect of three seaweed fertilizers in the form of liquid concentrates has been studied on a leafy vegetable fenugreek (*Trigonella foenum-graecum*). Seaweed concentrate of *Ulva fasciata, Sargassum ilicifolium and Gracillaria corticata* were prepared either by fresh extraction, boiling or soaking the alga in distilled water and a range of these SWC was applied to fenugreek seeds to observe germination. A few selected concentrations of SWC were further employed to analyze certain growth parameters and a few biochemical components from fenugreek. Plants raised in full strength Hoagland medium were used for comparison along with the control or untreated plants.

Results obtained in the present study are summarized in the following pages.

A. Analysis of seaweeds

Physico-chemical characteristic of seaweeds used for fertilizer application were analysed before the preparation of SWC.

1. Physical parameters

Green alga *Ulva* exhibited a green colour which appeared slightly faded when fresh extract was prepared. *Sargassum* is a brown alga so both the extract and thallus had the same colour. *Gracillaria* being red alga the extract also had a reddish colour.

The pH of all the seaweed liquid extracts varied only slightly and was near to 7 i.e. neutral. In *Sargassum* and *Gracillaria* it was inclined towards acidic range and in *Ulva* it was slightly above the neutral.

2. Biochemical composition of seaweeds

a. Total Carbohydrate content

The maximum sugars content was recorded in *Sargassum* a brown alga and minimum was found in *Gracillaria,* a member of Rhodophyceae. The values of carbohydrates recorded in the present study were found somewhat at a lower level than in other regions.

b. Total Proteins

The content did not vary much in different algal species and ranged from 3.3 to 3.8 $g100^{-1}g$ dry weight.

c. Total Lipids

Lipid content in the seaweeds under investigations was found to be low and within the recorded range. The lowering of lipid content in seaweeds of west coast of Maharashtra is might be due to high temperature of both climate and sea.

d. Ash Content

Sargassum ilicifolium exhibited a higher ash content (15.9%) than *Ulva fasciata* (7.5%) and *Gracillaria corticata* (10.8 %).

e. Inorganic elements from seaweeds

Total nitrogen content was reported to be high and varied from 9.08 to 14.35% dry weight, being maximum in *Ulva fasciata.* A high phosphorus content (5.5%) was present in *Gracillaria corticata* (red alga) as compared to brown and green algae. Potassium content was maximum in *Sargassum lilicifolium* (4.6%). Calcium content in *Gracillaria corticata* was marginally higher (4.34%) than in the other two species of seaweeds. Magnesium content did not vary much in different seaweed species. Iron and Manganese content were more in *Sargassum* as compared to *Ulva fasciata* and *Gracillaria corticata.*

The content of copper was less in different seaweeds under investigation and ranged from 0.9–1.2 mg/100g dry weight, Zinc plays very important role as an enzyme catalyst. Zinc content was varied from about 4.5-6.5 mg/100g dry weight in different seaweeds. Nickel is a relevant element and is of immediate concern due to its potential toxicity for living organisms. Nickel content varied from 0.74–1.2 mg/100g in *Sargassum*, *Ulva* and *Gracillaria.* Low levels of Ni content is beneficial as these extracts are sprayed on vegetables which may reduce the chances of Ni toxicity.

Analysis of Seaweeds revealed that they are rich in essential macro and micronutrients required for growth of plants.

B. Application of SWC to fenugreek

1. Germination

a. Petri plate study

All the SWC upto 50-60% promoted germination in fenugreek. At higher concentration slowly the rate of germination declined and was completely inhibited at 100% concentration of all the seaweeds. A cent percent germination was recorded on the third / fourth day after treatment for all the concentrations upto 50% for all the SWC used.

b. Plastic tray experiment

Effect of different SWC was studied by raising seeds in cocopeat and soil mixture in plastic trays. Fresh extracts of *Sargassum* and *Gracillaria* (10 and 25%) and *Ulva*, (25%) showed upto 20% germination on the first day which was not seen in control. On the third day a cent percent germination was recorded in all the treated seeds with control seeds giving 90% germination. Thus all the types of exacts, fresh, boiled and soaked positively influenced seed germination in fenugreek.

2. Growth

a. Shoot height

As the concentration of SWC treatment increased, growth also was found promoted. Maximum height of the plants was recorded at 50% concentration of all the fresh seaweed extracts and compared to control a significant increase was evident. The growth of seaweed treated plants was comparable to those of Hoagland treated ones. The rate of increase was

maximum on 15th day of growth and later on a decline was reported in all the seaweed extracts. The rate of growth at 50% concentration was maximum in all the types of extracts and seaweeds.

b. Fresh weight:

All the three types, i.e. fresh, boiled and soaked seaweed extracts enhanced fresh weight of treated plants as compared to control. The values recorded were greater than 1 g per plant for 50% concentrate of all the seaweeds whereas in control plants, it was 0.71 g per plant. Lower concentrations of SWC also enhanced the fresh weight of fenugreek plants.

c. Dry weight:

The dry weight was directly proportional to the concentration of seaweed applied and as the concentration raised the dry weight per plant also increased. Among the three seaweeds, soaked and boiled extract of *Ulva* and *Gracillaria* were quite effective than that of *Sargassum*.

d. Moisture percentage

Content of moisture declined as the concentration of treatment increased. A minimum moisture percentage was found in the fenugreek plants treated with 50% of all SWC. But it was greater than that in control plants in most of the treatments. Due to increased amount of cellular ingredients, i.e. organic materials, a reduction in the moisture percentage was quite obvious in the present study.

3. organic constituents

a. Photosynthetic pigments

All the seaweed concentrates had a positive effect on photosynthetic pigments at all the concentrations used. But comparatively, the fresh seaweed concentrate had shown a better effect than boiled and water soaked concentrates. The amount of chl.a, chl.b and total chlorophyll levels enhanced by about 5–10% over control in different treatments. The treatment of 50% seaweed concentrate particularly in *Sargassum* exhibited significant results and a maximum increase in total chlorophyll content was recorded at this concentration. Carotenoid level was also found influenced in the similar manner. A positive effect on photosynthetic pigments can be directly correlated with the increase in overall growth of the treated plants. Increased photosynthesis can lead to increase in yield and quality of the fenugreek.

b. Total carbohydrates

Fresh extract of all the seaweeds caused a rise in carbohydrates and 25 and 50% of *Sargassum* and *Gracillaria* SWC caused a remarkable changes in the sugar content. Water soaked extracts of all the three seaweeds caused nearly a similar effects on carbohydrates and only a marginal rise was seen in the treated plants.

c. Total soluble proteins

Protein content in fenugreek was enhanced by all the seaweed extracts applied at 25% and 50% concentrations. The fresh extract of all the seaweeds

caused a maximum enhancement in the protein content which was near about to Hoagland treated plants. At the lowest concentration (10%) the protein content was similar to that observed in the control plants in case of all the extracts.

d. ***Total free amino acids***

A remarkable elevation in free amino acids was observed in fenugreek plants treated with fresh extract of all the seaweeds. Water soaked and boiled seaweed extracts also produced similar results. Again the effective concentration was 50% for all the SWC.

e. Total Polyphenols

Fresh and boiled extract of the three seaweeds at 25 and 50% concentration caused a significant increase in the polyphenol content in fenugreek. With *Sargassum* and *Gracillaria* boiled extracts, the content was even higher than in the Hoagland treated plants. The accumulation of polyphenols may suggest increased resistance of plants after application of seaweed extract.

4. Mineral constituents

a. Total nitrogen content

Nitrogen content was not much affected by the treatment of seaweeds and only a marginal elevation was noticed at 25 and 50% concentration of all the three types of extracts. The values of nitrogen were slightly higher when fresh extract of algae was used for treatment.

b. Total ash content

With the fresh extract of all the seaweeds a rise in the ash content was found in fenugreek and the concentrations which gave maximum values of ash were 25 and 50%. With water soaked and boiled extracts a marginal increase occurred in ash content.

Germination, growth and metabolism in *Trigonella foenum-graecum* appeared positively influenced by the application of SWC in the form of foliar fertilizers. A significant variation in various cellular ingredients was evident in the treated fenugreek plants. Overall growth of treated plants was comparable to Hoagland-treated plants, which suggested a beneficial change in the physiology and biochemistry of plants by the application of seaweed concentrates. All the three concentrates prepared from green, brown and red seaweeds were effective in improving various physiological and biochemical parameters of the test plant i.e. fenugreek. The response documented for fresh SWC of *Sargassum* (brown) was better than for *Ulva* (green) and *Gracillaria* (red) concentrates.