IMPACT OF PESTICIDE ON THE GROWTH AND BIOCHEMICAL CONTENT OF SEAWEEDS

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ABSTRACT

The effect of Pesticide (monocrotophos) was studied on four economically important seaweeds, *Ulva lactuca, Caulerpa scalpelliformis*, *Padina tetrastromatica*, and *Gracilaria corticata*. The seaweeds were cultured in different concentration of monocrotophos mixed sterilized seawater. After 21 days of culture in the laboratory, the algae were harvested for the estimation of various growth and biochemical parameter like daily growth rate (DGR), chlorophyll, carotenoids, protein, carbohydrate, lipid and phycocolloids (agar and algin). In the present study, the brown seaweed *Padina tetrastromatica* responded well to pesticide by showing enhanced DGR, biochemical content including that of the phycocolloids (Algin). Rest of the seaweeds also responded positively by exhibiting good growth and biochemical increment but to a lesser extent and that too at certain concentrations only.

Keywords: Seaweeds, Pesticide, Pigments, Biochemicals

INTRODUCTION

Seaweeds are marine macro algae growing in the intertidal and subtidal regions of the seas, estuaries and backwaters. Based on pigmentation, seaweeds are broadly classified in to green, brown and red.

About 6000 species of red seaweeds (Rhodophyceae), 2000 species of brown seaweeds (Phaeophyceae) and 1200 species of green seaweeds (Chlorophyceae) occur globally. About 250 macroalgal species have been commercially utilized worldwide and about 150 species are consumed as human food (Sornalakshmi, 2017). They are the only source for the production of phytochemicals such as agar, carrageenan and algin (Sornalakshmi *et al.*, 2018). In India, rich seaweed beds occur only in certain areas. Several species of green, brown and red algae occur along the south coast of Tamilnadu (Kaliaperumal 2007).

Johnston (1976) has characterized three broad categories of marine pollutants namely native or natural which are not caused by man, generated by man but not created by him and the synthetic pollutants wholly created by him (man). One can broadly put hydrocarbon, soluble inorganic and organic substances in the first category, redistribution and exploitation by man of these hydrocarbons etc in the second and plastic, radionuclides and pesticides (DDT, BHC, etc) in the third.

The major stress on seaweeds in the coastal zone of Tamil Nadu is pollution, through various means. The coastal water has been exposed to many anthropogenic pressures and one such is the agricultural effluent which is responsible for internal perturbations like changes in food web structure. Plant protection products (Pesticide) occur in coastal water as a result of the impacts of upstream agricultural activities (Carafa, *et al* 2007). A combined additive effect of s-triazine mixtures on algae has been described (Faust *et al,* 2001). A bioaccumulation model to predict concentrations of s-triazine herbicides in the macro algae *Ulva rigida* has been implemented, calibrated and validated (Carafa *et al* 2009). So there is hardly any work on the impact of organochloride/organophosphate pesticide on the growth and biochemicals of the seaweeds.

In Tuticorin, untreated domestic sewage, effluents like fly ash waste from thermal station and effluent from petrochemical industries are discharged into the sea. All these heavily pollute seaweeds (Sornalakshmi and Venkataraman Kumar, 2014). Moreover the agricultural waste from in around Tuticorin is let into the Tuticorin marine waters. So in this research work, an attempt has been made to study the impact of the commercial pesticide, monocrotophos (organophosphorous) on the growth and biochemicals of some of the commonly available seaweeds from Tuticorin coast.

MATERIALS AND METHODS

Collection of seaweeds

Four species of seaweeds representing Chlorophyceae (*Ulva lactuca* Linnaeus, *Caulerpa scalpelliformis* (R.Brown ex Turner) C.Agardh), Phaeophyceae (*Padina tetrastromatica* Hauck) and Rhodophyceae *(Gracilaria corticata* (J. Agardh) were collected in the early morning low tide period from the red gate end of the Hare Island, Tuticorin. These were transported to the laboratory in polyethylene bags filled with seawater. The macroscopic epiphytes and other contaminants were carefully removed and used for bioassay test.

The commercially obtained organophosphorous pesticide under the brand name monocrotophos manufactured by Nagarjuna Agrichem. Ltd, Hyderabad was mixed precautiously using a mask and gloves with appropriate amount of sterilized seawater to get the following concentrations of pesticide mixed sterilized seawater culture media; 0.10, 0.25, 0.50, 0.75 and 1.00%.

Laboratory culture experiments

30.0 g fresh weight of each macro alga/seaweed was inoculated into cotton plugged 1 litre conical flasks containing 700 ml of sterilized seawater mixed with appropriate amount of the pesticide. The culture was maintained in the laboratory at 28± 2^{o}c, 800 lux light intensity under 16:8 LD cycle and periodical aeration from an aerator.

After 21 days of culture, the seaweeds were analysed for their following biochemical parameters. They are Daily Growth Rate (DGR) (Huglund *et al*, 1996), Chlorophyll a and carotenoids (Arnon 1949) as modified by Harborne (1973), chlorophyll c (Reeta Jayasankar and Ramalingam, 1993), Protein (Lowry *et al.*, 1951), Carbohydrate (Seifter *et al.*, 1950), Lipid (Bligh and Dyer, 1959) agar and algin (kaliaperumal and Ramalingam, 2002). Experiments were carried out in triplicates. Control was maintained by culturing the algae in sterilized seawater.

RESULTS

Ulva lactuca showed gradual decrement in DGR and carbohydrate content with increment in monocrotophos concentration from 0.1 to 1.0% (Fig. 1). At the lowest concentration (0.1%) of monocrotophos, the amount of chlorophyll a, chlorophyll b and carotenoid showed increment over the control. These three parameters showed gradual decrement at higher concentrations (0.25 to 1.0%). The levels of protein and lipid were also found to be lower than the control at all the concentrations of monocrotophos (Fig. 2-3).

In case of *Caulerpa scalpelliformis,* maximum DGR was recorded at 1.0% monocrotophos, that of chlorophyll a, chlorophyll b and carotenoid at 0.1% and protein at 0.25 and 0.50%. Both carbohydrate and lipid levels were lower than the control at all the concentrations of monocrotophos (Fig. 1, 4, 5).

At almost all the concentrations of monocrotophos, DGR, lipid and algin content of *Padina tetrastomatica* were more than the control. The amount of protein and carbohydrate exceeded over the control at some of the concentrations of monocrotophos. However, chlorophyll a, chlorophyll c and carotenoid content showed reduction with increment in monocrotophos concentration from 0.1 to 1.0% (Fig. 1, 6, 7, 10).

The red seaweed *Gracilaria corticata* exhibited DGR higher than the control at some of the concentrations of monocrotophos, maximum amount of chlorophyll a was recorded at 0.1% monocrotophos and at rest of the higher concentrations there was a gradual decline with the values lesser than the control. Values higher than control were recorded for carotenoids at 0.10 and 0.25% monocrotophos, thereafter declined. The amount of carbohydrate and lipid were lesser than the control at all the concentrations (0.10 to 1.00%) of monocrotophos. At all concentrations of monocrotophos, the protein content was more than the control. Though the agar content was lower than the control at almost all the concentrations, except 0.25% which showed the maximum content. (Fig. 1, 8-10).

DISCUSSION

In the present study, the brown seaweed *Padina tetrastromatica* responded well to pesticide by showing enhanced DGR, biochemical content including that of the phycocolloids (Algin of *Padina)*. Rest of the seaweeds also responded positively by exhibiting good growth and biochemical increment but to a lesser extent and that too at certain concentrations only. Again as on date there seems to be no work on the impact of pesticides on seaweeds. However there are reports on the bioaccumulation of herbicides by seaweeds like *Ulva rigida* (Cendergreen and Streibig, 2005; Carafa *et al*, 2009). The *cyanobacteria* or the blue green algae have been reported to accumulate very high concentration of insecticide (Dash and Mishra, 1999).

Perhaps the seaweeds are also capable of accumulating pesticides and grow comparatively better and synthesize higher amount of biochemicals including the economically viable phycocolloids. Flavoprotein systems isolated from algae seem to play a significant role in pesticide degradation in aquatic environments. Such flavoprotein systems are active in the degradation of xenobiotics both under aerobic and anaerobic condition by promoting photochemicals and reductive degradation activities (Dash and Misra, 1999). Presence of such flavoproteins have been reported in seaweeds and seagrasses.

(Venkataraman Kumar and Mohan 2000, 2003., Athiperumalsami *et al* 2008,2010). Perhaps such a type of mechanism could be functioning in seaweeds also to ward off pesticide toxicity.

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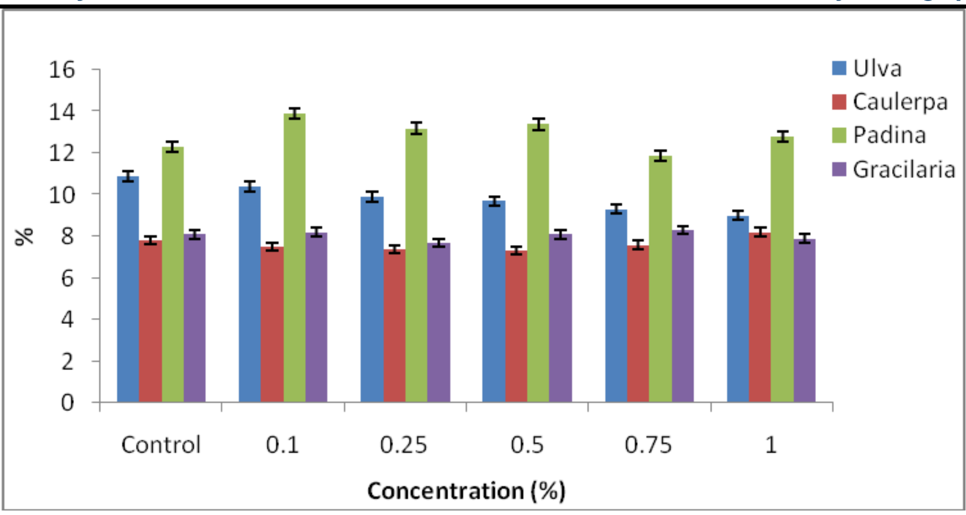

Fig. 1 Effect of pesticide (organophosphorous-monocrotophos) on Daily Growth Rate (DGR) of seaweeds

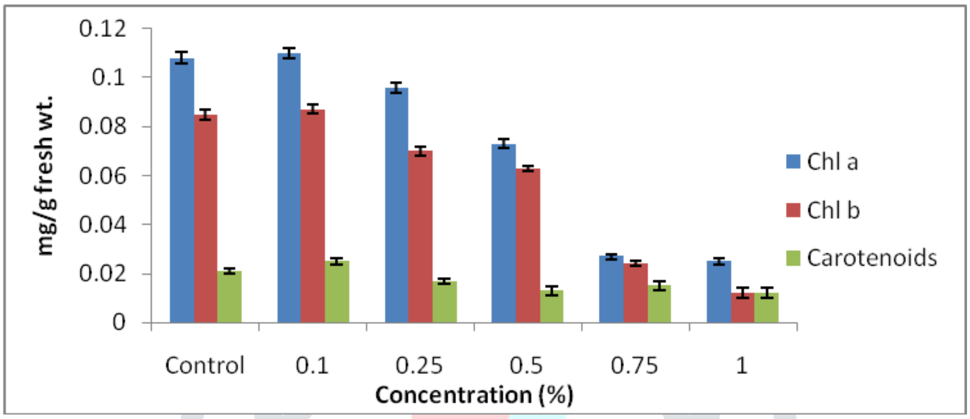

Fig. 2 Effect of pesticide (organophosphorous-monocrotophos) on pigments of *Ulva lactuca*

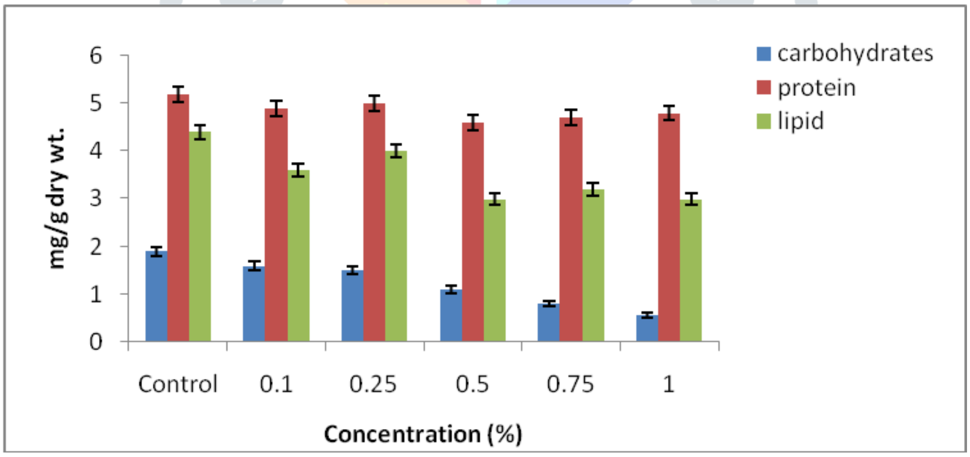

Fig. 3 Effect of pesticide (organophosphorous-monocrotophos) on biochemical content of *Ulva lactuca*

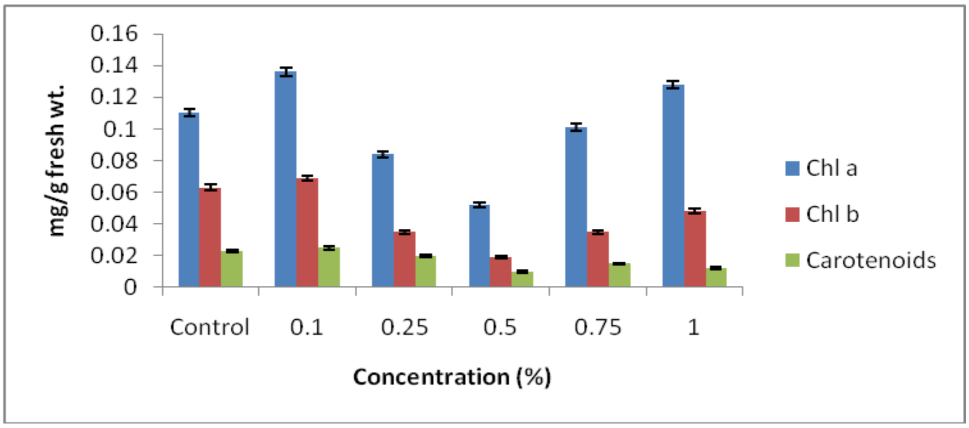

Fig. 4 Effect of pesticide (organophosphorous-monocrotophos) on pigments of *Caulerpa scalpelliformis*

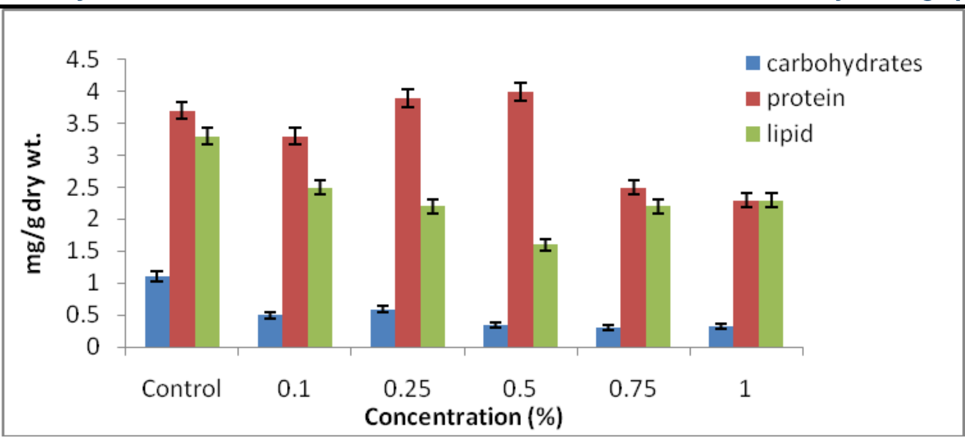

Fig. 5 Effect of pesticide (organophosphorous-monocrotophos) on biochemical content of *Caulerpa scalpelliformis*

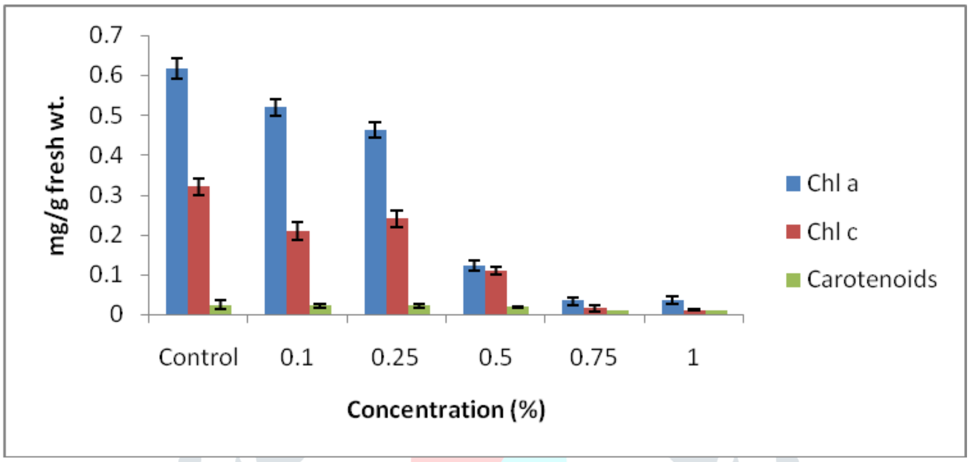

Fig. 6 Effect of pesticide (organophosphorous-monocrotophos) on pigments of *Padina tetrastromatica*

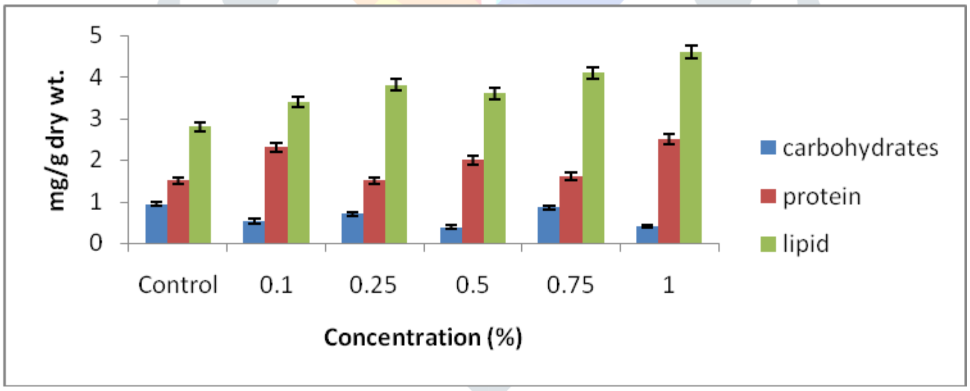

Fig. 7 Effect of pesticide (organophosphorous-monocrotophos) on biochemical content of *Padina tetrastromatica*

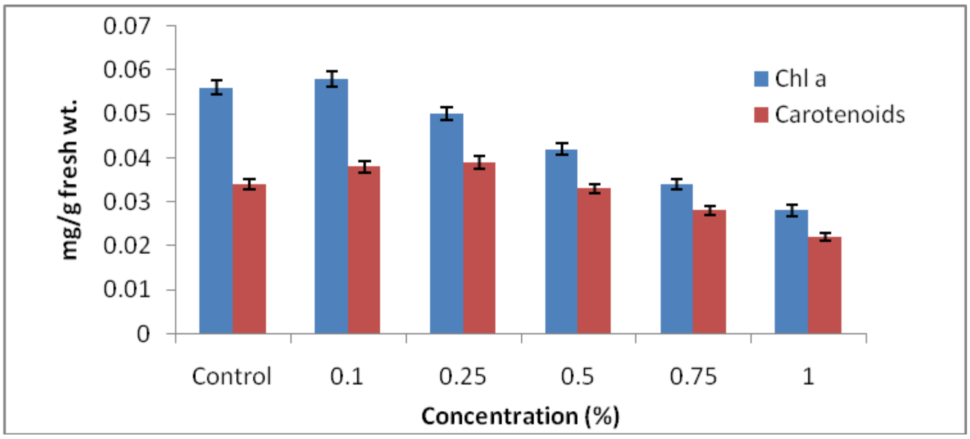

Fig. 8 Effect of pesticide (organophosphorous-monocrotophos) on pigments of *Gracilaria corticata*

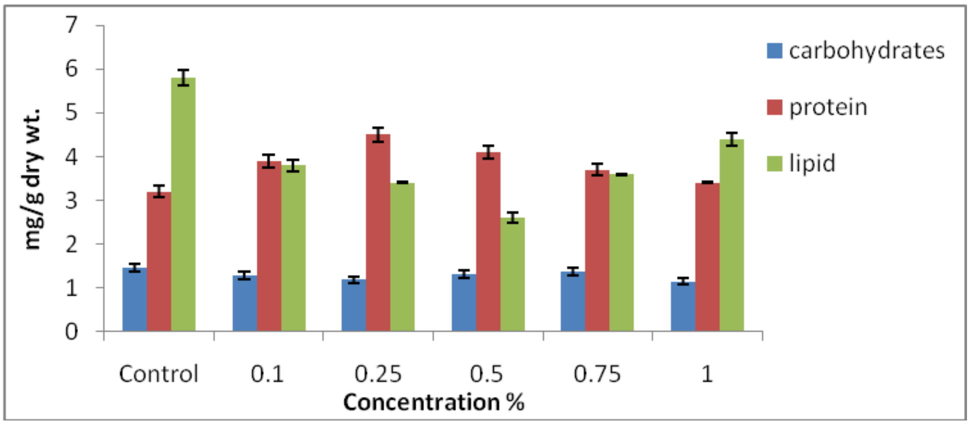

Fig. 9 Effect of pesticide (organophosphorous-monocrotophos) on biochemical content of *Gracilaria corticata*

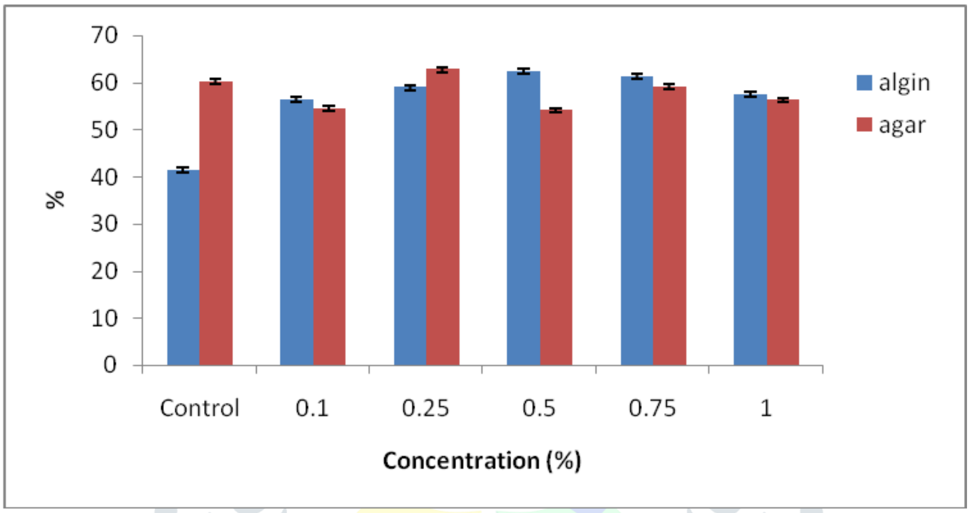

Fig. 10 Effect of pesticide (organophosphorous-monocrotophos) on phycocolloid content