Abstract of Ph.D. Thesis
Entitled

Studies on the Role of Selected Household Detergents in the Eutrophication of Fresh Water Ecosystem

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The water is an essential life supporting matter in every cell of an organism. It enters into the living organisms via absorption or ingestion. It circulates between biotic and abiotic components of the ecosystem. The misuse and reckless over consumption has resulted into the fast depletion of water resource. The nutrient enrichment of the water bodies caused from the natural and man made sources is depleting the water resources at a faster pace. The eutrophication is a kind of nutrient enrichment process of any aquatic body which results into an excessive growth of phytoplankton. The phosphate rocks and mineral sedimentation are the natural sources of phosphorus into the terrestrial and aquatic ecosystems. The household containing detergents and phosphorus fertilizers used in the agricultural practices are the major anthropogenic sources of phosphorus.

In the present study, the impact of some selected household detergents has been studied on the population, growth behaviour and development of two freshwater duckweeds, namely *Lemna minor* and *Spirodea polyrrhiza*. The growth responses of these selected free floating duckweeds to varying concentrations of ‘Surf Excel’ (the most
commonly used detergent) have been studied with special reference to varying temperature and pH.

The screening studies on the impact of 10, 30 and 50 ppm of 36 selected detergents (12 sold in the form of cakes and 24 in the form of powder) were conducted in small polyvinyl cups (of 180 ml capacity containing 150 ml detergent solution). In the screening experiments 10 plants of *Lemna minor* and 5 plants of *Spirodea polyrrhiza* were inoculated in the cups containing detergent solutions. The population growth of these duckweeds was studied at alternate days from the day of inoculation (3rd, 5th, 7th, 9th and 11th day). The dry weight per gram fresh weight was studied on 11th day.

There were three predominant types of population growth curves of both the selected duckweeds treated with 36 selected detergents. Some of the detergents increased the population growth of the two duckweeds in almost logarithmic progression showing increase in population with increase in the concentration (10-50 ppm). A few detergents increased population of both the selected duckweeds to a certain level of detergent concentration and then the growth became stationary with further increase in detergent concentration. In the third type of response, the duckweed population initially increased in response to a certain level of detergent concentration and declined at higher detergent concentration.

The detailed studies on the responses of the two selected weeds to 0, 10, 20, 30, 40 and 50 ppm of Surf Excel were carried out in large earthen pots containing 15 liters of the solution. In these pots, 100 individuals of *Lemna minor* and 20 individuals of *Spirodea polyrrhiza* were inoculated (singly or jointly) on day 1st from the pure duckweed stocks. The population of *Lemna minor* consistently increased up to 40 ppm level of Surf Excel and then declined at 50 ppm. In each concentration the population of
Lemna minor increased with the growth stage. The dry weight of Lemna minor also increased with the concentration level of Surf Excel. All concentration levels of Surf Excel increased NPK uptake in Lemna. Only lower concentration of Surf Excel significantly increased chlorophyll content in Lemna minor. The water quality studied in terms of turbidity and dissolved oxygen also decreased with the concentration of Surf Excel.

The population of Spirodela polyrrhiza in large earthen pots increased significantly at 40 ppm of Surf Excel. The impact of Surf Excel on the growth of Spirodela polyrrhiza was marginal at 3rd day showing a lag phase and then increased noticeably from day 7th onwards. The high concentration of Surf Excel neither increased the population significantly nor did it suppress. The chlorophyll content in Spirodela polyrrhiza increased on treatment with 40 ppm of Surf Excel. The NPK uptake also increased with the concentration of the detergent. The water quality decreased with the concentration of the detergent.

In the experiments with combined species (with the same initial number of individuals as studied separately), the population of both the species was found in the state of interspecific competition despite increased phosphorus containing detergent. The Surf Excel detergent promoted growth of both the duckweeds in almost all concentrations but not to the extent as studied in the experiments with single species. The individual pattern of growth response of both the duckweeds in the combined species was almost same as recorded in the experiments with single species. The chlorophyll content in both the species was significantly higher in response to 30 and 40 ppm of Surf Excel. The optimum response of most of the parameters of both the species was observed at 30 ppm of Surf Excel.
The impact of temperature (10°, 20°, 30°, 40° and 50°C) and pH (6.0, 6.5, 7.0, 7.5 and 8.0) on the sensitivity level of the duckweed grown in 0, 10, 20, 30, 40 and 50 ppm of Surf Excel was studied in polyvinyl pots. The optimum growth of *Lemna minor* was recorded at 30°C in all concentration levels. The peak of population growth of *Lemna minor* was observed on 11\(^{th}\) day in 40 ppm of Surf Excel maintained at 30°C. The 10°C temperature did not affect the growth response of *Lemna minor* and the higher temperature of 40°C and 50°C were deleterious. The optimum NPK uptake in *Lemna minor* was recorded at 20° and 30°C in the duckweeds treated with 30 and 40 ppm of the detergent. The phosphate uptake in the duckweeds and accumulation in water was found related with the temperature.

The population growth of *Spirodela polyrrhiza* increased at 20° and 30°C. At higher temperature (50°C) the population of *Spirodela polyrrhiza* did not survive by the 5\(^{th}\) day. The higher temperatures (40° and 50°C) reduced the dry weight accumulation in *Spirodela polyrrhiza*. The uptake of nitrogen and potassium increased at higher temperatures but the significant phosphorus uptake was recorded at even at lower temperature (10°C).

The population of *Lemna minor* was found to be inversely related with the pH range between 6-8 (6.0, 6.5, 7.0, 7.5 and 8.0). The acidic pH continued to increase the population even at higher concentration of Surf Excel (30-50 ppm). The uptake of nitrogen and phosphorus in *Lemna minor* was also found to be higher at relatively lower pH. In *Spirodela polyrrhiza*, the pH range 6.5 to 8.0 did not affect the population significantly. The optimum population growth of *Spirodela polyrrhiza* was observed at acidic pH 6.0 and 6.5 and treated with 30 and 40 ppm of the detergent. The lower pH increased dry matter accumulation in *Spirodela polyrrhiza*. The uptake of phosphorus in
Spirodela was found positively related with the detergent concentration rather than the pH level.

It was inferred from the observations that detergents play important role in promoting the growth of duckweeds. Out of 36 detergents studied, certain detergents effectively in promoted the growth of duckweeds even in low concentration. Certain brands of detergents resulted in consistent increase in the growth with increasing concentration. The detergents may effectively alter the duckweed diversity. Although, the impact of detergents on the duckweed diversity has not been explicitly studied but the finding of the experiments on the growth responses of the two duckweeds grown singly and in combination (in adequate water medium) are compelling.

The temperature effectively modified the duckweed response to the detergent. The cooler water medium had lesser degree of eutrophication than the moderately warm water medium. Not the phosphorus content alone, but the water quality (turbidity, pH, nutrient concentration and dissolved oxygen) modified by the detergent aggravated the problem of eutrophication. Therefore, the water bodies receiving acids from any source in addition to detergent are more likely to show a greater degree of eutrophication than a body receiving detergent without acids.