STUDY ON THE EFFECT OF SELECTED PESTICIDES ON THE PRIMARY PRODUCTION IN FRESH WATER POND AT TIRUVANNAMALAI, TAMIL NADU

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SYNOPSIS
In recent past, the pesticides usage is in large quantity in agriculture sector to control pest, weeds, insects and various diseases of cultivated crops. With grate advantage in using the synthetic pesticides on one hand, on the other hand, the bulk quantity usage of the pesticides may have toxic effect on natural ecosystem as well as crop productivity. In this regard our present investigation was more centered over the effect of the pesticides on the primary productivity of the two pond ecosystems.

The experimental ponds selected for this study are situated one at the Girivalam path around Tiruvannamalai Hill, Tiruvannamalai (12° 15’ NL and 79° 07’ EL) called as Singamuga kulam. The other pond is a form pond situated near Samudram Lake 2km away from the town, which surrounded by paddy fields. Both the ponds are eutrophic in nature with a dominance of Cyanophyceae during the study period. Water sample was analyzed for the concentration of various Physico-chemical parameters as described in APHA (1985).

Four pesticides selected for the investigations (Monocrotophos, Endosulfan, Methyl parathion and Malathion). The concentrations used during the investigations were 50µg/L, 100µg/L, 200µg/L, 350µg/L, 500µg/L, 750µg/L and 1000µg/L. The important physico – chemical parameters were analysed for the two experimental ponds. Both the ponds were alkaline throughout the period of study. Phytoplankton diversity was higher in the farm pond (75species) than the domestic pond (71 species).

Of the four pesticides, monocrotophos (1.19% >in D. pond and 0.411% >in F. pond) and endosulfan(0.77% >in D. pond and 0.64% >in F. pond) showed an increasing level of GPP at 50µg/L concentration in both the ponds. Nevertheless, the other two pesticides, methyl parathion (0.286% <in D. pond and 1.11% <in F. pond) and malathion (0.516% <in D. pond and 2.28% <in F. pond) showed decreasing trend. From 100-µg/L concentrations onwards-decreasing trend was observed in all the four pesticides in both the ponds. Based on GPP in D. pond monocrotophos 24.17% > endosulfan 32.13 > malathion 38.45% > methyl parathion 42.08% whereas in F. pond monocrotophos 35.09% > endosulfan 40.11% > methyl parathion 45.67 > malathion 46.08%.The net primary productivity in both the ponds for all the pesticides even at the minimum concentration (50µg/L) level also reduced to 25%. At minimum concentration the percentage of reduction of NPP was ranged form 25.75% to 37.16% for all the pesticides in Domestic pond, whereas the range for the Farm pond was slightly higher (36.74% to 39.46%) for all the pesticides in both the ponds at 200-µg/L. Above 90% reduction in NPP was observed in all the pesticides in both the ponds at 500-µg/L.
There was an increasing trend in respiration for all the four pesticides in both the ponds from 50-µg/L to 350-µg/L concentrations were noticed. At the same concentration for the pesticide Endosulfan the percentage of increase was 28.96% in F. pond, whereas in the D. pond for the same pesticide in the same concentration it was 59.79%. The same kind of trends was also noticed in Methyl parathion and Monocrotophos. All analysis was statistically proved and the results are discussed.

**INTRODUCTION**

Pesticides are substances used to control pests, including insects, water weeds, and plant diseases. Naturally occurring pesticides have been used for centuries, but widespread production and use of modern synthetic pesticides begin from 1940 onwards. Now there are currently about 21,000 pesticide products formulated from some 860 different active ingredients in use. Agriculture is the major user of pesticides, accounting for 75% of use by volume. Industrial and commercial users (18%), and home and garden users (7%) account for the remaining volume (Belfroid et al., 1996; Cox and Walker, 1999). Pesticides can protect against forest and farm crop losses and can aid in more efficient food production. They are used to establish and maintain lawns and recreational areas. They are used to reduce malnutrition and starvation of humans and animals. Pesticides also have been instrumental in controlling many insect-borne human diseases such as malaria, encephalitis, and bubonic plague. Pesticides are (a) relatively easy to apply, (b) generally cost-effective and, (c) the only practical method of control in some situations. However, the benefits of pesticides are not derived without its consequences. The toxicity that makes them useful in controlling pests also poses potential risks for humans and the environment. Pesticides must be used with great care so that the health of humans, animals, and the environment are protected. Disadvantages of pesticides include their toxicity to some humans, animals, and useful plants, and the persistence (long life) of some of these chemicals in the environment (Larsson et al., 1988; Jones, 1990; Ditoro et al., 1991; Biswas and Konar, 2001).

In the modern agriculture large amounts of pesticides are used and aquatic ecosystems, such as ponds, are sometimes contaminated directly or indirectly. Residues of pesticides are regularly found in both surface- and groundwater. In experimental pond tests, it has been shown that pesticide exposure can cause changes in the composition and function of plankton communities (Biswas and Konar, 2001). Natural ecosystems however, have not been examined to such a great extent. Therefore we have had investigated whether similar trends could be seen in natural ponds.

**MATERIALS AND METHOD**

The experimental ponds selected for this study are situated one at the Girivalam path around Tiruvannamalai Hill, Tiruvannamalai (12° 15’ NL and 79° 07’ EL) called as Singamuga kulam. The other pond is a form pond situated near Samudram Lake 2km away from the town,
which surrounded by paddy fields. Both the ponds are eutrophic in nature with a dominance of Cyanophyceae during the study period. Water sample was analyzed for the concentration of various Physico-chemical parameters as described in APHA (1985). Phytoplankton samples were collected as described elsewhere (Ramakrishnan, 1981). Pesticides selected for the present study is based on the quantity they can be used for agricultural and domestic purposes. Local people used major quantity for the various crops like paddy, groundnut and various millets. The pesticides selected for the present investigation are Monocrotophos, Endosulfan, Methyl parathion and Malathion. Based on repeated experiment done for these pesticides and consulting the agriculturist for selecting suitable LD$_{50}$ concentration for the experiment. Finally the following concentrations were selected for the present investigations are 50µg/L, 100µg/L, 200µg/L, 350µg/L, 500µg/L, 750µg/L and 1000µg/L by using suitable dilutions and concentrations maintained in 300 ml BOD bottles Primary productivity was determined by light and dark bottle method (Wetzel, 1965). BOD bottles of 300ml capacity were used in the experiments and dissolved oxygen determinations were made by modified Winkler’s method. All the results are statistically proved using the software Statistica (1996).

RESULTS AND DISCUSSIONS

The major physicochemical parameters were analysed for the two experimental ponds and the results are presented in the Table 1. Both the ponds were alkaline throughout the period of study. The secchi disc recorded the low value in farm pond than the domestic pond indicated that the rich phytoplankton population in the farm pond than the domestic pond. Higher total solids recorded in domestic pond than the farm pond during the present investigations. There was an interesting observation recorded during the present study was slightly the higher calcium level in the domestic pond than the farm pond (Kanshik et al., 1991). Nevertheless, magnesium level was higher in the farm pond than the domestic pond. As for the nutrients are concerned higher nutrient level was observed in the farm pond than the domestic pond indicated that the farm pond was approaching the eutrophic condition than the domestic pond (Saha et al., 1971; Croome and Tyler, 1972; Obeng and Asamona, 1972; Prasad, 1995).
Division wise Phytoplankton diversity and density in the experimental Ponds

The phytoplankton diversity of various divisions was analysed during the experimental days and the results are presented in the Figure 1. More diversity was noticed in the farm pond (75 species) than the domestic pond (71 species). The present observation is in contrast the earlier findings in the same ponds (Ramakrishnan 1991). The phytoplankton density was recorded during the experimental days in the two ponds. The results are shown in the Figure 2, clearly indicated that higher density was observed in the farm pond than the domestic pond generally.

EFFECT OF PESTICIDES ON THE GROSS PRIMARY PRODUCTION

In the present investigation the effect of four pesticides on phytoplankton primary productivity (GPP and NPP) was measured and the results of GPP is given in the figures 3 and 4 for the Domestic pond and Farm pond respectively.

Two pesticides used in the present investigation like monocrotophos (1.19% > in D. pond and 0.411% > in F. pond) and endosulfan (0.77% > in D. pond and 0.64% > in F. pond) showed an increasing level of GPP in both the ponds (Fig.3). Nevertheless, the other two pesticides, methyl parathion (0.286% < in D. pond and 1.11% < in F. pond) and malathion (0.516% < in D. pond and 2.28% < in F. pond) showed decreasing trend. From 100-µg/l concentrations onwards-decreasing trend was observed in all the four pesticides in both the ponds (Giddings, 1983). However, at 100 µg/l the decreasing level was below 10% for all pesticides in both the ponds, except methyl parathion in F. pond where the reduction is slightly below 10% i.e. 10.51%. It is interesting to note that at 200-µg/l concentrations the reduction in percentage was ranged from 14.31% to 23.73% for all the four pesticides in the D. pond. However, in the Farm pond the reduction in percentage was ranged from 26.49% to 35.17% for all the four pesticides. This results in conformity with Pettersson (1990); Palmer et al. (1997).

At 350-µg/l concentrations, very low percentage of reduction (24.17%) was observed in monocrotophos in the D. pond. The order of arrangement of pesticides based on GPP reduction percentage was differ in both the ponds i.e. in D. pond monocrotophos 24.17% > endosulfan 32.13% > malathion 38.45% > methyl parathion 42.08% whereas in F. pond monocrotophos 35.09% > endosulfan 40.11% > methyl parathion 45.67% > malathion 46.08% (Laws et al., 1991). Based on the present investigation the LD₅₀ level for all the four pesticides was noted at 500-µg/l concentrations. However, monocrotophos in both the ponds showed the reduction was approaching 50% level i.e. 49.35% in D. pond and 49.39% in F. pond and also in D. pond the malathion, showed the reduction in percentage was only 48.86%. At 750-µg/l concentrations the reduction percentage was above 75% in all pesticides of both the ponds was recorded. Highest percentage of reduction in GPP was recorded in methyl parathion (86.4%) and malathion (86.66%) in the F. pond only. In both the ponds for all the four pesticides no detectable GPP was observed at 1000-µg/l during the present study. This result is in conformity with many earlier workers in different parts of the world (Franco et al., 1984; Levy et al., 1985; deNoyelles & Kettle, 1985; Laws et al., 1991; Lancelot et al., 1998).

EFFECT OF PESTICIDES ON THE NET PRIMARY PRODUCTION (NPP)
In the present investigation the effect of four pesticides on phytoplankton primary productivity (GPP and NPP) was measured and the results of NPP is presented in the figures 5 and 6 for the Domestic pond and Farm pond respectively.

The net primary productivity in both the ponds for all the pesticides even at the minimum concentration (50-µg/l) level also reduced to 25% during the present investigation. At minimum concentration the percentage of reduction of NPP was ranged from 25.75% to 37.16% for all the pesticides in Domestic pond, whereas the range for the Farm pond was slightly higher i.e. from 36.74% to 39.46% for all the pesticides. More than 50% reduction in NPP level was observed for all the pesticides in both the ponds at 200-µg/l. Above 90% reduction in NPP was observed in all the pesticides in both the ponds at 500-µg/l (Arnold & Briggs, 1990).

**EFFECT OF PESTICIDES ON THE COMMUNITY RESPIRATION**

In the present investigation the effect of four pesticides on community respiration was estimated and the results are presented in the figure 7 and 8 for the Domestic pond and Farm pond respectively. During the present investigation there was an increasing trend in respiration for all the four pesticides in both the ponds from 50-µg/l to 350-µg/l concentration was noticed. Very low percentage of increase was observed in Malathion 23.19% in the F. pond, whereas in the D. pond the increase percentage for the same pesticide was 43.73%. At the same concentration for the pesticide Endosulfan the percentage of increase was 28.96% in F. pond, whereas in the D. pond for the same pesticide in the same concentration it was 59.79%. The same kind of trends was also noticed in Methyl parathion and Monocrotophos also. These results indicated that in the D. pond, zooplankton concentration was greater than the F. pond (Boyle, 1980; Giddings et al., 1984; 1985). In higher concentrations the respiration rate gets lower from 500-µg/l in all the pesticides in both the ponds and at 1000 -µg/l concentration no respiration was detected in all the four pesticides in both the ponds (Boyle, 1980).

Correlation analysis was carried out between the effect of four pesticides on GPP in two ponds and on observing the results there is no single negative correlation clearly indicated that the experimental protocol is proved to be correct and most of the r-value are 0.9 and significant at p< 0.05 levels also showed the uniform effect of the pesticides on GPP (Hammons and Giddings, 1981; Hammons, 1981)

**REFERENCES**


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**Statistica 1996.** *Statistica* Students Edition Release 5.0 Window operating systems; SPSS & SAS Printed in USA web:http://www.statsoft.com


**Correlation matrix between effect of the pesticide on GPP in the Pond I and II**

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<th>ENDO_PII</th>
<th>METH_PII</th>
<th>MALA_PII</th>
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<th>ENDO_PI</th>
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MONO_PII – Effect of Monocrotophos on GPP in Pond II ; ENDO_PII – Effect of Endosulfan on GPP in Pond II ; METH_PII – Effect of Methyl Parathion on GPP in Pond II ; MALA_PII – Effect of Malathion on GPP in Pond II

MONO_PI – Effect of Monocrotophos on GPP in Pond I ; ENDO_PI – Effect of Endosulfan on GPP in Pond I ; METH_PI – Effect of Methyl Parathion on GPP in Pond I ; MALA_PI – Effect of Malathion on GPP in Pond I
Table 1. Physicochemical parameters of the experimental ponds

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