

Carbamate and Organochlorine pesticide tolerance of Cyanobacteria *Nostoc muscorum* and their effect on nitrogen fixation

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ABSTRACT

In the present study, nitrogen fixation efficiency of Cyanobacteria (blue-green alga) *Nostoc muscorum* was tested at increasing concentration of commercial grade pesticides Sevin (carbaryl, 50%) and Endotaf (endosulfan, 35%). Estimation of total nitrogen (%) fixed by the tested alga at each concentration (ppm) of pesticides was carried out by using conventional Micro- kjeldahl method. The pragmatic results revealed that, in the presence of 20 ppm of Sevin and even 5 ppm dose level of Endotaf pesticides, total nitrogen content was consistently decreased with the further increase concentrations of pesticides. At the higher dose level i.e. 250 ppm of Sevin and 100 ppm of endotaf, *Nostoc muscorum* showed 86.9% and 95.0% decrease in total nitrogen content over the untreated control respectively. On the other hand, at 500 ppm concentration of Sevin and 250 ppm of Endotaf pesticide, growth and nitrogen fixation was ceased in the tested blue-green alga. In general, it was seen that higher levels of pesticides application i.e. more than 20 ppm of Sevin and even 10 ppm of Endotaf adversely affected the occurrence and survivability of *Nostoc muscorum* in the laboratory cultures which is responsible for nitrogen fixation. It was concluded that indiscriminate use of studied pesticides had deleterious effect on nitrogen fixation of cyanobacteria *Nostoc muscorum* while the recommended doses of field application, the studied pesticides had no adverse effect under various crop fields.

Keywords: *Nostoc muscorum*, Sevin and Endotaf pesticides, Nitrogen fixation, Micro- kjeldahl method.

INTRODUCTION

Cyanobacteria are unique prokaryotic organisms with the ability to perform mutually compatible functions like biological nitrogen fixation and photosynthesis. The cyanobacteria contain nitrogenase and fix atmospheric nitrogen for which these attained remarkable practical importance since last 2- 3 decades as biofertilizer [1]. They have tremendous potential in environmental management as soil conditioner, biofertilizer, biomonitors of soil fertility, water quality, feed for animals and protein supplements [2].

In Maharashtra state, the agro- ecological conditions are favourable for the growth of blue-green algae and has great scope for its adoption to marginal farmers. *Nostoc*, *Hapalosiphon*, *Aulosira*, *Anabaena* and *Calothrix* were dominant nitrogen fixing cyanobacteria encountered in various agro-practices areas of Kopergaon tahsil, Maharashtra state. Such forms hold promise for crops such as maize, rice, mungbean, tomato and sugarcane [3] and wheat [4] by fixing nitrogen. However, the agronomic potential of blue-green algae is currently little exploited. An indepth agroecological research is an essential requisite for the sustainable improvement of blue-green algal technology [5].

One of the problem that has been noticed under field conditions is the destruction of blue-green algal populations by pesticide application intended to control the insects and pests of the various agricultural crops [6,7]. Variety of pesticides like organochlorines, organophosphates, carbamates and synthetic pyrethroids are now in use. These agrochemicals also damage wide variety of beneficial microorganisms because of their long persistence in the environment [8]. Therefore, pesticides used in routine applications in crop fields have important environmental effects in addition to those usually intended.

Such investigations are useful in awakening the farmers to adopt better farm management practices that in turn will reduce the chemical fertilizer input and problem of environmental degradation due to excessive use of pesticides. By considering all these issues along with societal responsibilities the present study was done on tolerance of commonly used pesticides carbamate, Sevin and organochlorine,

Endotaf pesticides and their effect on nitrogen fixation of cyanobacteria *Nostoc muscorum* isolated from agro-practices areas of Kopergaon tahsil, Maharashtra state.

METHODOLOGY

In the present work, effect of commonly used pesticides Sevin (carbaryl, 50%) and Endotaf (endosulfan, 35%) belonging to carbamate and organochlorine group, was studied on the tolerance and nitrogen fixation of soil blue-green alga *Nostoc muscorum*. These pesticides are generally used to control sucking, lepidopterous and nematode pests and mites that occurred in maize, wheat, sugarcane, cotton, onion, vegetable and oil yielding crops of the study area. The pesticide application rates recommended to control various crop pests of this region are 0.75 kg/ha for carbaryl Sevin and 0.7 liter/ha for endosulfan (Endotaf) and domethoate (Rogor) which will provide a range of 5- 10 ppm in the agricultural crop field.

During the experiment, two commercial grade pesticides as carbamate, Sevin (Union Carbide Ltd.) and organochlorine, Endotaf (Rallis India Ltd.) were used. Stock solutions of these pesticides were prepared freshly for experiments in the sterilized media and added to the 50 ml of nitrogen free BG-11 culture media to obtain the desired concentrations (2.5, 5, 10, 20, 50, 100, 250 and 500 ppm) of each pesticide. The pH of all the media was adjusted to 7.5. Total nitrogen fixed by the cyanobacteria *Nostoc muscorum* at each concentration of two pesticides was estimated by conventional Micro- kjeldahl method [9] after 28 days of harvesting in the laboratory cultures. Experiments were conducted in triplicate sets by inoculating equal amounts of actively growing tested unialgal isolate into cotton stoppered conical flasks.

RESULTS AND DISCUSSION

The practical results as depicted in Table- 1 regarding nitrogen fixation potential of Cyanobacteria, *Nostoc muscorum* at 2.5, 5, 10, 20, 50, 100, 250 and 500 ppm concentrations of each studied pesticides in laboratory cultures were proved statistically significant. The

tested blue-green alga *Nostoc muscorum* showed increased total nitrogen content upto 10 ppm concentration of Sevin over the control. While in the presence of 20 ppm dose level of Sevin pesticide, total nitrogen content was consistently decreased with the further increase concentrations of pesticides. At the higher dose level i.e. 250 ppm of Sevin, *N. muscorum* showed 86.9% decrease in total nitrogen content over the untreated control. On the other hand, at 500 ppm concentration of Sevin pesticide, growth and nitrogen fixation was ceased in the tested blue-green alga *Nostoc muscorum* (Fig. 1).

Concurrently, with Endotaf at 5 ppm concentration, progressive decline in nitrogen fixation occurred upto 100 ppm concentration where decrease in total nitrogen content was observed by 95.0% than the control in *Nostoc muscorum*. Further increase in dose

level (i.e. above 100 ppm) of Endotaf pesticide, resulted into ending of growth and nitrogen fixation of *Nostoc muscorum* (Fig. 1).

The results obtained during the present investigation revealed that in laboratory cultures, the carbamate pesticide Sevin was less toxic than organochlorine, Endotaf to the tested cyanobacteria *Nostoc muscorum*. Further, a progressive decline in the nitrogen fixation of tested blue-green alga occurs with increasing concentrations of each pesticides. Among the different pesticides treatments, Endotaf was found to be highly toxic to *Nostoc muscorum* than the Sevin pesticide treatments. The reduction in total nitrogen content of the pesticide-adapted cyanobacteria *Nostoc muscorum* strain may occurred due to the inhibition of some stage(s) during the process of nitrogen fixation in the presence of higher concentrations of pesticides.

Table 1: Total nitrogen (%) fixed by *Nostoc muscorum* at different concentrations of Sevin (carbaryl, 50%) and Endotaf (endosulfan, 35%) pesticides. (Harvested after 28 days of incubation).

Conc. of pesticides (ppm)	0.00 (Control)	2.5	5	10	20	50	100	250	500
Sevin	4.89	4.96 (+1.4)	5.14 (+5.1)	4.96 (+1.4)	3.41 (-30.2)	2.00 (-59.1)	1.17 (-76.0)	0.64 (-86.9)	--
Endotaf	4.89	5.10 (+4.2)	4.27 (-12.6)	3.10 (-36.6)	2.00 (-59.1)	1.05 (-78.5)	0.24 (-95.0)	--	--

Values represents total nitrogen (%) mean of three replicates; figures in parenthesis () show percent increase (+) or decrease (-) relative to the total nitrogen in the control.

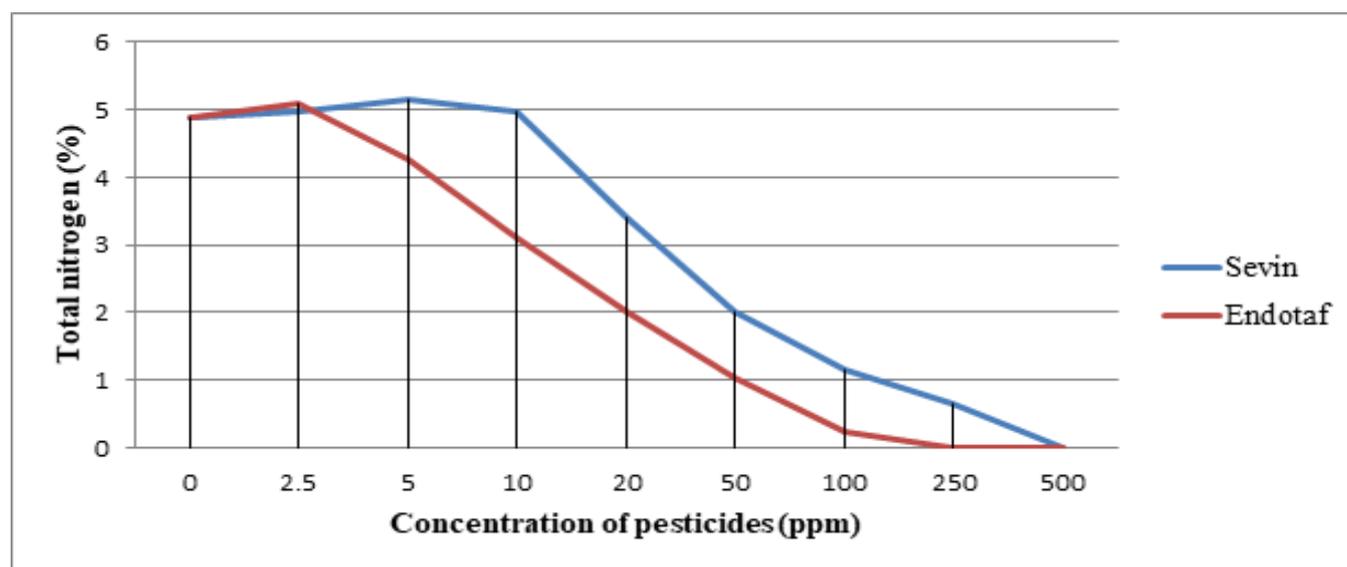


Fig. 1: Tolerance of Sevin (carbaryl, 50%) and Endotaf (endosulfan, 35%) pesticides on total nitrogen (%) fixed by *Nostoc muscorum*.

Further stimulatory effect of Furadan, Sevin at lower concentrations on nitrogen fixation by blue-green algae under culture conditions may be due to the presence of nutrients in media that minimizes the toxicity of carbofuran [10,11]. These views are coincides with the reports of earlier workers; Furadan [10]; Sevin [12]; organo- chlorine [13]; Monocrotophos and Butachlor [14] and Rogor [15].

CONCLUSION

In general, it was seen that higher levels of pesticides application i.e. more than 20 ppm of Sevin and even 10 ppm of Endotaf adversely affected the occurrence and survivability of *Nostoc muscorum* in the laboratory culture which is responsible for nitrogen fixation. It was concluded that at the recommended doses of field application, the studied pesticides had no deleterious effect on nitrogen fixation of tested cyanobacteria *Nostoc muscorum*. Caution should be taken to determine the appropriate application dosage of these agrochemicals before applying them into the crop fields. Further it was also suggested that field studies on the blue-green algal population in pesticide burdened soils is required to be supplemented the data generated in the laboratory for proper analysis.

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