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Effect of dichlorvos on growth of *Scenedesmus acutus*

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Abtract

The effect of the dichlorvos on growth of the freshwater microalga *Scenedesmus acutus* was investigated. In general, the growth rate of *S. acutus* in control cultures are always high between 0 to 4 days, but that of cultures treated with dichlorvos were suddenly decreasing between 2 to 4 days. In contrast, in all control cultures the growth rate of *S. acutus* was always negative. These results demonstrated adverse effects of dichlorvos upon freshwater green algae (*Scenedesmus acutus*), thus, the application of this pesticide for control in agricultural practices must be done carefully since any disturbance affecting algae with similar or higher sensitivity will have severe repercussions on higher trophic levels.

Keywords: Growth rate, Dichlorvos, Algae, *Scenedesmus acutus*

INTRODUCTION

Nowadays, more than 10.000 chemicals are currently used in industrial and agricultural applications. Some of these chemicals unpredictable effects when discharged into aquatic ecosystems. Consequently, there is enormous interest in estimating these effects before contamination occurs [1]. Although the instructions for use of these chemicals aim at minimizing the risk of contamination of aquatic environments, residuals of pesticides can be detected in water courses draining agricultural areas. Algae are essential components of aquatic ecosystems. They produce oxygen and organic substances on which most other life forms depend to provide food for other organisms, including fish and invertebrates. Chemical effects on algae can directly affect the structure and function of an ecosystem, resulting in oxygen depletion, decreased primary productivity, increased surface runoff and soil erosion, and degradation [2]. Algae are known to be comparatively sensitive to many chemicals, and the inclusion of these organisms in test batteries has been shown to improve the capacity of the battery to predict the most sensitive ecosystem responses. Furthermore, the importance of these organisms as dominating primary producers in most aquatic ecosystems speaks for their use in test batteries for environmental hazard assessment [3].

Although pesticides are designed specifically to destroy unwanted target organisms, their application may cause many diverse problems to non-target organisms like fish, birds, and even human being. The effects of pesticides on aquatic environment were frequently evaluated using organisms, such as fish or water flea [4]. Effects of pesticides in the ecosystems do not remain restricted to target organisms but rather extend to non-target organisms such as algae which play an important role in the primary production of the aquatic ecosystems [5,6]. Toxicity of some pesticide on algae is higher than toxicity reported by several authors on organisms like zooplankton, filter-feeding invertebrates and fishes [7,8].

Dichlorvos is an organophosphate compound used to control household, public health, and stored product insects. It is effective against mushroom flies, aphids, spider mites, caterpillars, and white flies in greenhouse, outdoor fruit, and vegetable crops. Dichlorvos (DDVP) is used to treat a variety of parasitic worm infections in dog, livestock, and humans. Dichlorvos is generally found to be toxic to algae [9,10].

A lot of works have been published about the comparative sensitivity of dichlorvos towards various aquatic organisms. The effects of dichlorvos on phyto and zooplankton is generally found to be toxic. Some reports on the comparative sensitivity of pesticides toward various green algae have been published [11,12]. Much information on the toxicological aspects of insecticides on green algae has been complied; however, little about the toxicological aspect of dichlorvos on algae is known [13]. Dichlorvos is generally found to be toxic to zooplankton [9], mollusks [14], crustacean [15], and fish [16].

Dichlorvos is widely used in developing countries such as Turkey to control of pest. Therefore, in the present study, a green alga *Scenedesmus acutus* has been studied in axenic culture exposed to different concentrations of dichlorvos. Since *Scenedesmus acutus* dominate the local aquatic environments. This study reports the effects of dichlorvos on different concentrations upon population growth of *Scenedesmus acutus*.

MATERIALS and METHODS

Dichlorvos is an organophosphate compound used to control household, public health, and stored product insect. Dichlorvos (2,2-dichlorovinyl dimethyl phosphate) is a commonly used pesticide for pest comtrol in the agricultural fields around these freshwater reservoirs.

The green alga *Scenedesmus acutus* was isolated from plankton samples in a fishpond. *S. acutus* was grown in sterilized Jaworski's Medium. The media was composed of distilled water and the following chemical ingredients Ca(NO3)2.4H2O, KH2PO4, MgSO4.7H2O, NaHCO3, EDTA FeNa, EDTA Na2, H3BO3, MnCl2.4H2O, (NH2)6Mo7O2H2O, NaNO3, Na2HPO4, Cyanocobalamin, Thiamine and Biotin. The culture medium was sterilized at 121 ºC, 1.05 kg cm-2 for 30 min. Single species experiment was carried out to know the change in the total cell number. *S. acutus* was exposed to various concentrations of dichlorvos. Algal toxicity test of 96 hr (4 days) of exposition was conducted following the general design of Environmental Protection Agency [9]. The incubation time chosen to investigate the effect of dichlorvos on growth of *S. acutus* was 4 days (96 hours), which is comparable to previous studies on the effects of other chemicals on algae growth. The stock and experimental cultures were grown in the same liquid medium at a temperature of 23± 1ºC and a light intensity of 2000 lux on a 16 h light and 8 h dark photoperiod. The inocula was prepared from these culture to provide an initial cell density 40.000 cell/mL of *S. acutus* in treated and control culture. Dichlorvos was added to the *S. acutus* culture just after inoculums. Control cultures were incubated in the same medium without dichlorvos.

The experimental sets were run in triplicate, and all cultures were hand shaken twice daily. After the cultures were incubated, *S. acutus* cells were counted with an inverted microscope at 0, 24, 48, 72 and 96 h (1, 2, 3, 4 days).

RESULTS AND DISCUSSION

Dichlorvos affected *Scenedesmus acutus* in a different manner. In Figure 1, different pattern of growth of the cultures exposed to different concentrations of dichlorvos can be seen. Control cultures with the same cellular density as the treated ones were prepared, in order to determine the effect of dichlorvos on population growth of *S. acutus*. The growth of *S. acutus* was significantly inhibited in all treatments when compared with the control (Fig.1).

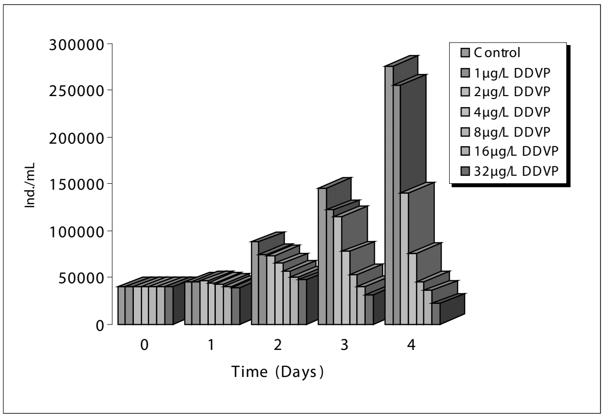

Figure 1. Effect to different concentrations of dichlorvos to population growth of *Scenedesmus acutus*

The observation of toxic effects of dichlorvos on *S. acutus* indicated a significant decrease in population growth, with respect to the control in the treated cultures at all assayed concentrations at first day. *S. acutus* in control culture was counted as 45000 cells/mL. But in treated culture to 1, 2, 4, 8, 16 and 32 µg/L of dichlorvos, *S. acutus* was counted as 45600, 46200, 44320, 43000, 40600 and 39600 cells/mL, respectively.

At second day, *S. acutus* was counted in control culture as 88000 cells/mL. The effect of dichlorvos on population growth of *S. acutus* was noticed when growth of all treated cultures significantly decreased with respect to the control at second day of inoculation. *S. acutus* declined by 74600, 73200, 65200, 57000, 50600 and 47600 cells/mL at 1, 2, 4, 8, 16 and 32 µg/L, respectively. The effects of dichlorvos on *S. acutus* were noticed when growth ration of some treated cultures, decreased significantly with respect to the control at 48 hr of exposition. Especially, there was a significant inhibition of growth with respect to the control, of the cultures exposed above 2 µg/L at 48 hr of exposition

At third day, there were continued decreases at growth of *S. acutus* in treated cultures but green algae were significant increase in control culture. In fourth and fifth days, population growth of *S. acutus* was significantly decreased in treated cultures with dichlorvos. At concentrations of 8 - 32 µg/L dichlorvos, growth of *S. acutus* was completely finished.

The effects of dichlorvos on *Scenedesmus acutus* were noticed when growth of all cultures exposed, decreased significantly with respect to the control at 48 hr (second day) exposition. The cultures exposed from 4 µg and higher showed a significant inhibition growth respect to the control.

The effects of pesticides on growth, reproduction, photosynthesis and other metabolic activities of algae were investigated by different workers [17,18]. Investigations with different green algal species have shown that algae vary greatly in their response to chemical. Differential sensitivity of the green algae to the compounds could induce species shifts within communities [19]. The loss of a few, particularly sensitive, phytoplankton species from a community containing hundreds of species may not be considered significant, as long as the function of the community remains unchanged. Most of the work in mixed culture of algae showed that application of pesticide resulted in elimination of sensitive species [8]. Sensitivity to toxicants is important in determining the suitability of a test for adoption into chemical regulations. The toxicities of some pesticides to species of phytoplankton and toxicity data published for several species of phytoplankton with other herbicides have shown that the variations in sensitivity may be considerable [3, 20]. In the present study, different concentrations of dichlorvos decreased the population growth of *S. acutus*.

The results of this study indicate that sensitivities to dichlorvos of *S. acutus* began in first day of inoculation and in this time, the algae decreased in treated culture with dichlorvos.

Growth rate of *S. acutus* were always high between 0 to 4 days in control cultures but treated cultures with dichlorvos continuously decreased at all concentrations between 1 to 5 days. In contrast, in the control culture the growth rate of *S. acutus* was always positive at interval 1 to 4 days. In general, the growth rate of *S. acutus* was found to be negative correlated with high concentration of dichlorvos. Because of the above results, the use of dichlorvos, would cause both acute and chronic damages to natural green algae populations commonly present in aquatic environment. This is an important fact because in the freshwater ecosystem, algae are important primary producers in the food chain, with phytoplankton providing food for a diverse community of invertebrates and fish. Depending on the pesticide toxicity, wetland contamination could result in a die-off of many present algal species, decreasing this food source. This would also affect the the development of non-target organisms closely connected, by means of its food relationships.

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