بسم الله الرحمن الرحيم

Effect of some herbicides on growth and biochemical constituents of some phytoplankton

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This thesis has not been previously submitted for any degree at this or other university

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Dedication

To my Father and my mother

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INTRODUCTION

Introduction

In recent years, there has been an intensive use of the herbicides for controlling a variety of weeds, specially the water hyacinth in the River Nile. The success of physical barriers and mechanical cleaning to control the hydrophytes has been rather limited. It became, therefore, logical to exploit the effectiveness of the herbicides for controlling aquatic weeds which have successfully employed in our country. Some of these herbicides such as Ametryn, Stomp and Machete effectively inhibit growth, metabolic and photosynthetic activities of most aquatic macrophytes.

The present study was conducted in order to provide a specific information about the side effects of these herbicides namely Ametryn, Stomp and Machete on growth and productivity of phytoplankton communities as represented by *Scenedesmus quadricauda, Staurastrum netator* (green algae) and *Microcystis flos-aquae* (blue-green).

Historical Review

Many of the commonly used herbicides exert a long lasting effect on aquatic organisms for different periods of time ranging between 2 and 11 days, while other herbicides can persist for longer periods up to 3 months before being broken down (Newbold, 1975). Losses of herbicides from water can be due to four processes according to the assumption of Newbold (1975):

1- Volatilization at the interface of air and water.

2- Break down by bacteria or light or both of them.

3- Chelation of ionic binding to the mud and suspended solids in the water.

4- Absorption by the fauna and flora.

Hoffman (1953) concluded that if herbicides act upon the normal sites within the plant cell, the following can be deduced:

1- Plant growth inhibition caused by growing substances or herbicides at the molecular level.

2- The herbicides combine with the active sites of the plant cells.

3- The herbicides - mechanism complex reacts irreversibly in direct proportion to the concentration of such product.

Hollister and Walsh (1973) reported that, when analyses are conducted for effects of herbicides on unicellular algae, two factors are particularly important:

1- The response in relation to familial taxonomic position.

2- The wide range of responses by individual species within a given family.

Ametryn, [2- (Ethylamino) -4- (isopropylamino) -6- (methylthio) -s-triazine], one of the triazine herbicide has a commercial name of Gesapax (WSSA, 1983 and Meister, 1983). It is a selective herbicide used for controlling broad leaf and grass weeds in pineapple, sugarcane, bananas and plantains. It is also used as a postdirected spray in corn, a potato vine desiccant and for total vegetative control (WSSA, 1983).

Recently, the distribution and flourishing of water hyacinth throughout the River Nile and drains led to the application of herbicides such as Ametryn for controlling its growth. Ametryn has been found in 2 of 1,190 surface water samples analyzed and in 24 of 560 ground-water samples (Lewis, 1989). The maximum concentration found was 0.1 μg/L in surface water and 450 μg/L in ground water.

In aqueous solution, Ametryn is stable in natural sunlight, with a half-life greater than 1 week. When exposed to artificial light for 6 hours, 75% of applied Ametryn remained. One photolysis product was identified as 2- ethylamino -4- hydroxy -6- isopropylamino -s- triazine (Registrant CBI data). Under sterile conditions, Ametryn does not degrade appreciably. Therefore, microbial degradation is a major degradation pathway.

Response of freshwater alga *Scenedesmus* to triazine herbicides including the effect of Ametryn on *Scenedesmus* sp. was studied by El Dib et al.(1989).

Responses of four algal species to 30 herbicidal formulation have been reported by Walsh (1972) and Walsh and Grow (1971). They reported that the urea and triazine herbicides (including Ametryn) were the most toxic, these herbicides caused depression of the carbohydrate contents of the algae.

Effects of herbicides on phytoplankton were characterized by inhibition of oxygen evolution. Both ureas and triazines (Ametryn) inhibit photosynthesis and move quickly into the cells (Zweig, 1969) and the concentrations requested for inhibition of both growth and photosynthesis are the same (Hollister and Walsh, 1973).

Effect of four triazine herbicides on growth of nontarget green algae was studied and *Scenedesmus quadricauda* was used as criterion for measuring algal growth (Hiranpradit and Foy, 1992).

Oettmeier et al. (1991) investigated the structure-activity relationships of triazinone herbicides on resistant weeds and resistant *Chlamydomonas reinhardtii*.

Ritter et al. (1989) pointed out that triazine herbicides are potent inhibitors of photoinduced electron transport mediated by isolated chloroplasts and the triazines are considered to bind to the 32 kilo dalton (KD) protein of the photosystem II reaction center.

De Noyelles et al. (1982) reported detectable effects of Atrazine (Triazine herbicide) on algal productivity and species composition.

Goldsborough and Robinson (1983) studied the effect of Simazine (Triazine herbicide) and terbutryn on the productivity of freshwater algae.

Mayasich et al. (1986) reported that Atrazine effectively inhibit growth and photosynthesis of most plants including freshwater algae.

Jurgensen and Hoagland (1990) investigated the effects of short-term pulses of Atrazine on attached algal communities in a small stream. Many of the early reports on the effects of Atrazine on algae involved mainly unialgal cultures of planktonic species (Wells and Chappel, 1965 and Ashton et al., 1966). Butler et al. (1975) found that Atrazine concentration as low as 10 µg/L is inhibitory to algae. Subsequent work by De Noyelles et al. (1982) demonstrated that 20 pp. had a negative impact on algal productivity and biomass.

Hamala and Kollig (1985) found a dramatic decline in attached algae density and diversity in artificial streams exposed to 100 pp. Atrazine. Declines in attached algae biomass and chlorophyll a in artificial streams were also reported by Krieger et al. (1988).

Severe inhibition of attached algae photosynthesis, productivity and biovolume also occurs at high Atrazine concentrations in artificial streams (Kosinski and Merkle, 1984 and Moorehead and Kosinski, 1986), whereas little or no effect has been observed at low concentrations (Lynch et al., 1985 and Krieger et al., 1988).

Dose-response relationship of *Anabaena flos-aquae* and *Selenastrum capricornutum* to Atrazine and Hexazionoe using chlorophyll a content and C^{14} uptake had been reported by Abou-Waly et al. (1991).

The inhibitory effect of Simazine (one of the Triazine herbicides) on the Hill reaction and its influence on development of the green alga *Scenedesmus quadricauda* was studied by Hendrich et al. (1976).

Gast (1958) showed that Simazine blocked starch formation in *Coleus blumei* Benth. in the light. Other studies involved the distribution of C^{14}-labled photosynthetates by excised bean leaves from plants previously treated with Hill reaction inhibitor Atrazine (Zweig and Ashton, 1962). The major action of aminotriazine compounds apparently is to inhibit photosynthesis (Exer, 1958; Gast, 1958; Moreland et al., 1958; Moreland et al., 1959; Ashton et al., 1960 and Zweig and Ashton, 1962).