GROWTH INHIBITION OF BLOOM-FORMING USING RICE STRAW IN WATER COURSES (CASE STUDY)

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ABSTRACT

Algae cause a number of problems in water. They impede flow in irrigation system and cause taint and odour problems in potable waters… etc. In Egypt, one of the main canals called Suez Canal has become eutrophic as a result of the input of excessive plant nutrients from agricultural activities. Filamentous algae is the most common aquatic weeds problem in Suez canal where it is sudden appearance as it floats off the bottom produce undesirable odours and spoils the taste of drinking water. In this research, a novel method of controlling algae by using rice straw has been investigated in Suez Canal. It offers a cheap, environmentally acceptable way of controlling algae. The decomposition of rice straw in water produces and releases many compounds. Hydrogen peroxide may be considered the main substance in controlling algae. Also the analysis of water samples indicated that the chemical compound does not eliminate existing algae cells but interferes with and prevents the growth of new algae cells.

As long as rotted straw was existed, no filamentous algae were recorded due to the synergistic effects of various humic substances in the rice straw.

The criteria of using rice straw such as means of fixing the straw, quantity and timing of applying in such an open canal has been pointed out in order to obtain an acceptable result.

Keywords: Algae – Rice straw – chlorophyll a – Suez Canal – Egypt.

INTRODUCTION

Algae cause a number of problems. They impede flow in drainage systems, block pumps and sluices, interfere with navigation, fishing and other forms of recreation, cause taint and odour problems in potable waters, block filters and, in some instances, create a health hazard to humans, livestock and wildlife. These problems are highly increased because nutrient concentrations in water are rising as a result of human activity and natural processes. The simultaneous and growing demands worldwide for improvements in water quality are expected to be supreme priority in the near future.

The need to control algae, therefore, is increasing for environmental, recreational and public health reasons.

Because of their small size and rapid growth rates, unicellular algae are difficult to be controlled by the traditional methods used for other aquatic plants. Cutting and other forms of mechanical control can help to minimize problems with filamentous algae but are of very limited use and not efficient. Algae are susceptible to herbicides, but this approach is unpopular in some water on environmental or public health grounds. Furthermore, herbicides that control algae also kill higher plants so that, although the water is cleared temporarily of all plants, once the herbicide has gone from the water, the regrowth of algae is not restricted by competition from the higher plants and the problem may worsen in subsequent years.

In Suez Canal, sometimes serious problems of unbalanced biological conditions arise, produce undesirable odours and spoil the taste of drinking water. Over growth of algae causes floating crusts in limited area of the last reach of the Suez Canal (from km 60.000 to km 84.000). The water blooms have been recorded in Suez Canal annually for several years being high during low temperature period.

Rice straw has received considerable attention as an algaecide based on research done in many countries throughout the world and has proved to be very successful side-effects.

So, in this research a novel method of controlling algae by using rice straw has been investigated to clarify how rice straw can produce significant reductions in algae activity proliferation in Suez Canal.

STUDY AREA

The layout of the Suez canal and surrounding area as shown in Figure (1). The canal act as conveyors of water for irrigation and urban supplies. Thirty five thousand feddans (14200 ha) is supplied by the canal along with 75000 m^3/day for drinking and industrial demands to Suez city.

The Suez Canal has been selected in this study due to the fact that about 26 drinking water treatment plants were constructed along the canal.

MATERIALS AND METHODS

Doses and techniques of the straw consistent with recommendations found in the literature were used in this study. Firstly, the straw was broken a part. The straw can be put into net, nylon stocking which include some form of float in the net (Figure 2). Then, the straw was placed in Suez Canal as barriers during June 2005. The barriers are made to allow water to pass through them and to sustain the wave and wind action.

Previous field studies reference volumetric dosages ranging from 25- 400 g/m^3, whereas the popular literature (i.e. fact sheets) suggests using areal dosages ranging from 25 - 50 g/m^2.

Rice straw doses consistent with field trials and the popular literature were chosen for this study. The intended dose in Suez Canal was 50 g/m^2, which are the effective quantity that required controlling algal growth and the straw staid about six months to fully decompose.

The straw was applied following the guidelines suggested by Newman (1999) with addition some modification in the design of mesh bags. The present study was carried out during June 2005 to January 2006. Integrated water samples were collected from the control and treated season in Suez Canal. Algae concentrations were determined by measuring chlorophyll a concentrations, turbidity as surrogates. In addition, dissolved oxygen was measured to ensure that aeration units were functioning. A known volume of the water sample was filtered (in situ) on glass micro fiber filter GF/C, using filtration unit (sartorius). Chlorophyll a extracted in 90% acetone over night, filtered, measured and calculated (SCOR/LINESCO, 1991).

Turbidity was measured in the field by using spectrophotometer (Lamott). The dissolved oxygen was measured simultaneously in situ with an oxygen probe (yellow spring instruments oxygen meter model 51B).

RESULTS AND DISCUSSION

1. Mechanism of straw

As the barriers of straw are placed in water, the soluble components of the straw are washed out, causing water to change in color. The chemical released by the straw does not kill algal cells already present but it prevents the growth of new algal cells. Thus the died algae will not be replaced when the straw is present and so the algal problem is controlled.

The exact mechanism by which straw controls algae have been proven we believe that the process may occur as follows:-

When straw rots, chemicals in the cell walls decompose at different rates. According to Gibson *et al.* (1990) and Ridge and Barrett, (1992), organic toxins, that inhibit phytoplankton growth, are produced by the decomposition of the rotting straw in freshwater and may help to prevent significant algal blooms.

Lignins are very persistent and are likely to remain and be released in the water as the other components decay. If there is plenty of oxygen available in the water, lignin can be oxidized to humic acids and other humic substances. These humic substances occur naturally in many waters and it has been shown that, when sunlight shines on to water, which contains dissolved oxygen in the presence of humic substances, hydrogen peroxide is formed. Low levels of peroxide are known to inhibit the growth of algae. Peroxides are very reactive molecules and will only last in water for a short time. However, when humic substances are present, peroxides will be continuously generated whenever there is sufficient sunlight.

2. Chlorophyll a

The amount of chlorophyll a in water is an index of phytoplankton productivity and has been used to estimate the primary productivity in combination with data on photosynthetic activity on chlorophyll a basis and light conditions in freshwater as well as in marine environments (Ichimura *et al.*1962, Aruga & Monsi 1963).

The seasonal changes of the average chlorophyll a concentration before and after using the rice straw in Suez Canal are illustrated in Table (1). The results show that the averages of chlorophyll a concentrations were slightly higher at June 2005 (7.38 mg/l), before applying the rice straw than at January 2006 (5-14 mg/l), after applying the rice straw (the season of algae growth). These results agree with the results of Park *et al.*, 2006 which mentioned that the cell numbers of the algal strain *M. aeruginosa* significantly decreased after treatment with different concentrations of rice straw extract for an 8-day cultivation period.

3. Turbidity

Turbidity values ranged from 4.8 NTU to 13.9 NTU in June 2005 (control season), and ranged from 7.14 NTU to 18.4 NTU in January 2006 (treated season). The mean turbidity value of the treated season in Suez Canal (i.e. after applying rice straw) was similar to the control season (i.e. before applying rice straw) at 9.96 NTU in June 2005 and 9.92 NTU in January 2006 (table 1).

4. Dissolved oxygen

There was little dissolved oxygen variability among control and treated season (table 1). The dissolved oxygen concentrations ranged from 4.6 to 6.36 mg/l in June 2005 and ranged from 6.1 to 8.9 mg/l in January 2006 respectively. Mean dissolved oxygen concentrations were 6.36 mg/l and 7.77 mg/l in June 2005 and January 2006, respectively. The result indicates that there is no negative impact from rice straw in the aspect of dissolved oxygen in Suez Canal.

Several case studies have shown that biomanipulation can be effective on water bodies with excessive amounts of algae and agree with the present results (Everall and Lees 1996, Ridge and Barrett 1992, Gibson *et al.* 1990, Beaton and Monahan 2000 and Randall 2002).

Finally, the identification of rice straw as an effective material for the growth of algae, it may help the potential to be used an environment friendly biomaterial for controlling the algal bloom in Suez Canal.

Table (1): Minimum, Maximum, and Mean values for some parameters before and after applying rice straw.

Parameter	Units	Season	Min.	Max.	Mean value
Chlorophyll a	µg/l	June 2005	4.09	9.93	6.12
		January 2006	1.14	7.61	5.14
Turbidity	NTU	June 2005	4.8	13.9	9.96
		January 2006	7.14	18.4	9.92
Dissolved oxygen	mg/l	June 2005	4.6	7.5	6.36
		January 2006	6.1	8.9	7.77

CONCLUSION AND RECOMMENDATIONS

It could be concluded from this study that the growth of algae was inhibited by rice straw. This activity was due to the synergistic effects of various compounds in the rice straw. The findings and the basic rules of this study are summarized as follows:

1- Although the straw can be applied at any time of year, it is much more effective if applied before algal growth begins. Straw should be applied in spring before algal growth starts. This is because the antialgal agents released by the straw are more effective in preventing algal growth than in killing algae already present.
2- Straw works best if it is held close to the water surface where water movements are greatest. This keeps the straw well oxygenated and helps to distribute the anti-algal chemical.
3- If the straw starts to smell then it is not working and should be removed.
4- Although the decomposition of straw produces a chemical to control algae, the chemicals have not resulted in any documented ill effects to fish, waterfowl, or humans. The chemicals produced during this process are naturally occurring and produced by the decomposition of any plant material in water.
5- Filamentous algae are not easily controlled by straw once they have formed floating mats. However, they can be controlled by other methods.

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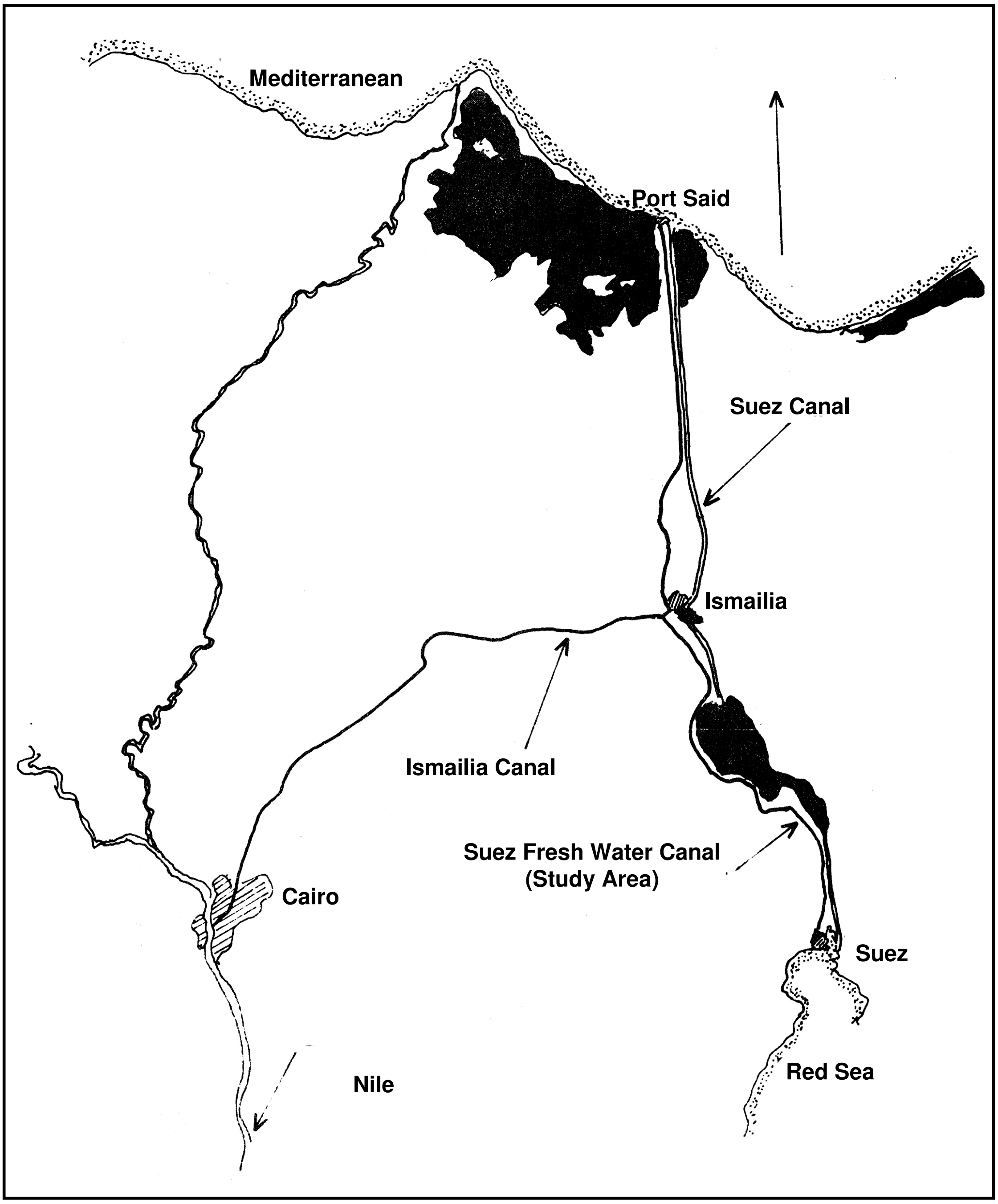

Figure (1): Map of the Suez Canal.

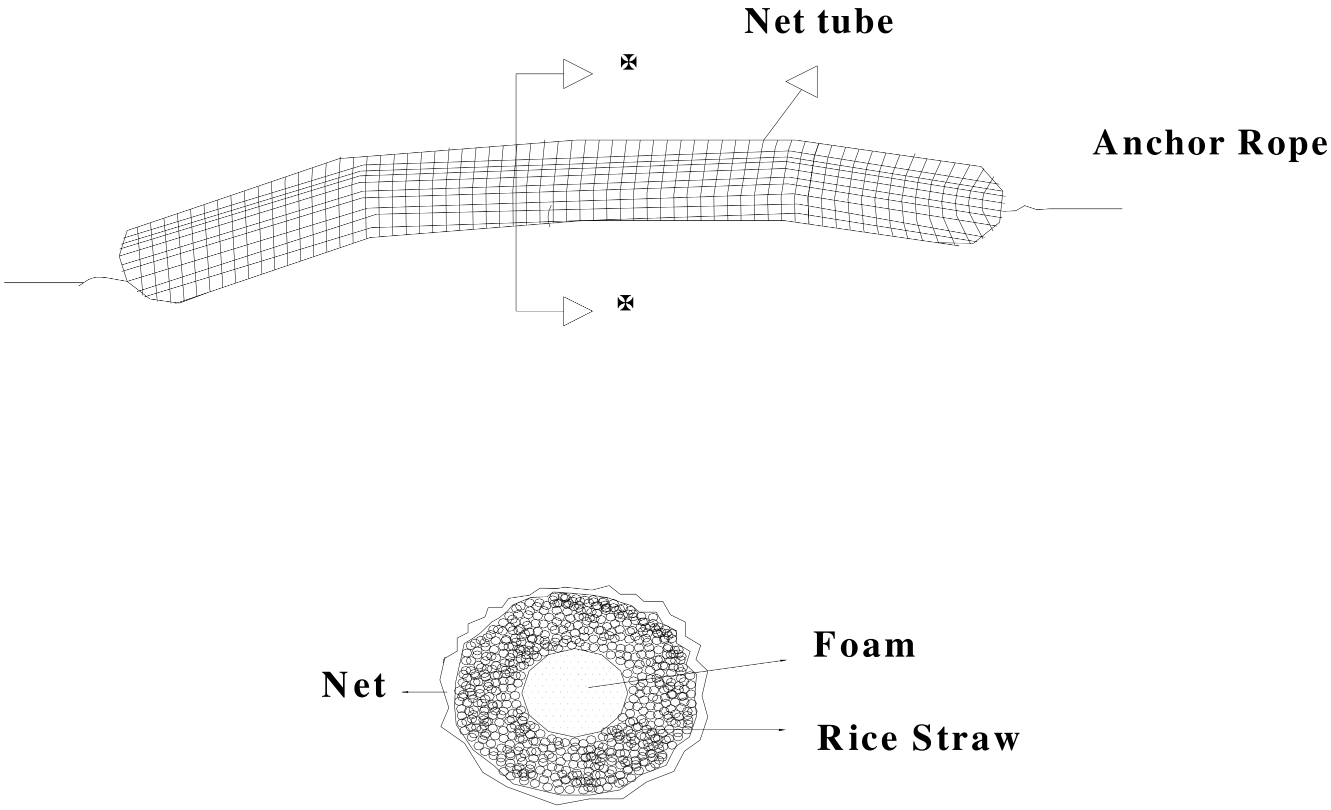

Figure (2): Longitudinal and cross section of rice straw barriers