THE INFLUENCE OF ALGAE GROWTH ON THE RATING CURVE OF CONCRETE LINED CANALS

A. Drovandi, Medina de Dias, R. E. I., Zimmermann, M.

INTRODUCTION

In arid and semi-arid areas of many developing countries, irrigation is an essential prerequisite for agriculture. Yaron (1981) mentions that about one-third of the world's irrigated lands are affected by soil salinity problems. The necessary water flow through the supply and drainage channels of irrigation systems is often very seriously impeded by excessive algae and aquatic weed growth as such channels are a very favourable habitat for aquatic plant growth (shallow water, high light intensities, high temperatures, high nutrient levels).

Aquatic weeds and algae increase the frictional roughness of the channel (Pitlo & Dawson 1990). This increases management costs by necessitating control measures, increases flood risk, and reduces water availability for irrigated crops. The slower water movement in the channels can also result in water table rise and hence water logging and salinization problems.

With respect to the drainage system the problem can be an improper drainage from the lands into the channels. Smedema & Rycroft (1983) argue about the importance of channel maintenance and state that when it is not properly done the channels may become so obstructed by vegetation that they are unable to even discharge summer rains adequately. This might enhance salinization reaching dangerous levels for cultivation.

Pitlo and Dawson (1990) present some statements about the difficulties that aquatic vegetation can produce. They mention aquatic vegetation as one of the main factors influencing the movement of water flowing in natural and artificial watercourses. They also mention that the vegetation within the watercourse and along its margins can cause major variations in the resistance to flow, a problem most frequently experienced in lowland watercourses. According to them, the presence of vegetation may affect the flow in a channel as follows:

- by reducing water velocity thus raising water levels in the channels and also in the water table in adjacent land causing it to become waterlogged
- by increasing the flooding or overbank spill (i.e. increasing flood risk)
- by encouraging the deposition of suspended sediment (i.e. aggregation) which may have to be removed to maintain the waterway depending upon the rate of accretion, which may vary seasonally
- by changing the magnitude and direction of currents within a channel thus causing local erosion or reducing bank erosion, depending on the location, extent and density of the vegetation
- by interfering with other water uses, e.g. navigation and recreation.

Algae are of special interest because they include the most primitive forms of plants. They have no true roots, stems, or leaves, and do not produce flowers or seeds, as higher plants do. Yet all other groups of plants have probably evolved from algae. The most primitive divisions comprise that group of plants commonly referred to as algae. Most algae live in fresh or salt water and have a very simple growth form. These life forms are ancient: the first algae appeared on the Earth well over a billion years ago. The green algae (division Chlorophycophyta) include relatively simple plants with abundant chlorophyll in their cells. The brown algae (division Phaeophycophyta) and red algae (division Rhodophycophyta) include the organisms commonly called seaweeds. Like the green algae, they have chlorophyll in their cells, but it is hidden by other pigments. The yellow-green and golden algae (division Chrysophycophyta), which include the diatoms, have golden-brown pigments and are surrounded by delicate glasslike shells.

Botanically algae are classified among the thallophytes, along with fungi, lichens, and primitive, single-celled plants and bacteria. Thallophytes are plants devoid of true roots, stems, leaves, or flowers. Certain algae have some qualities of plants and some qualities of animals. They are sometimes called protozoan animals, or they may be classified as protists, somewhere between the plant and animal kingdoms.

The simplest algae single cells of protoplasm float about in the water and absorb food through their thin cell walls. They multiply vegetatively; one cell buds from another by simple cell division. Among the larger kinds of algae, methods of reproduction vary greatly. Sometimes a small section breaks away from the main plant to grow into another complete new plant. This is called fragmentation. Or budding cells may remain clinging to the parent cells. Sometimes they bud all around the sides and form mats, or flat networks of cells. Some of these nets and mats float onto rocks in quiet places where the motion of the water is not strong enough to float them off again. The cells on the rocks cannot gather much food, so they cling while the floating cells wave in the water, gather the food, bud, and spread into feathery, leaflike fronds. Certain cells collect budding material in little raised dots on the fronds. When the dots ripen, they are washed off. These bud dots are spores (tiny reproductive bodies, usually only a single cell, that can develop into a new plant). Some algae produce spores called gametes. Two gametes of opposite sex must unite to produce the cell that will develop into a new alga. Spores and gametes are simpler than seeds. The cells that cling to the rocks suggest roots, and the cells that spread out and float are hints of leaves.

In the natural world, algae are the chief food source for fishes and for all other types of organisms that live in the water. They also contribute substantially to the store of oxygen on Earth. There are about 25,000 species of algae. The simplest alga consists of a single cell of protoplasm, a living jellylike drop. No larger than three microns, the size of a large bacterium, it is visible only under a microscope. The most complex algae are the giant kelps of the ocean that may be 200 feet (60 meters) long.Algae are found all over the Earth, in oceans, rivers, lakes, streams, ponds, and marshes.

All algae contain the green pigment chlorophyll. This substance makes it possible for algae to use the energy of sunlight to manufacture their own food (carbohydrates) out of carbon dioxide and water. This process is called photosynthesis. Other pigments also are present, giving the different algae the distinct colors that are used as a basis of classification.

Blue-green algae often appear as blue-green, brown, or black stains, cushions, or layers. They may be numerous enough to color a body of water.

Although most freshwater algae are microscopic, many kinds are gregarious and occur in such numbers as to form the well known "water-blooms" or ponds scums. A few genera are individually large enough to be seen readily without the aid of a microscope, e.g., the stoneworts (Characeae) or some of the freshwater red algae such as *Batrachospermum* and *Lemanea*, or globular, colonial forms such as the blue-green algae *Nostoc*.

If it were possible for freshwater algae to grow as large as some other plants (mosses or ferns for example) and to live upon land, they would be considered highly attractive indeed and would be much cultivated as ornamentals. It is not the aesthetic quality of freshwater algae alone which explains the amount of interest shown them. For small though they are, freshwater algae (like some of their microscopic kin in the oceans) have many economic importances and considerable biological significance.

Their relationship to aquatic biological problems such as the food chain, their troublesome contamination of water supplies, and their use in general physiological research constitute just a few of the many aspects which lead to a study of them. Purely scientific problems, such as the role of algae in organic evolution, the biology of their reproduction and life histories, and their ecology are common subjects of investigation. Altough much is still to be learned from them, the solution, or at least clarifications, of many problems in general biology and physiology have been obtained from studies of algae. At this time, for example, much attention is being given algae in culture for the study of highly important and practical problems in photosynthesis and the products of algal metabolism. Some genera of unicellular algae are being used for the assay and detection of biologicals (vitamins and growth-promoting or growth-inhibiting substances).

Losee and Wetzel (1983) stated that periphyton consists of a matrix of algae, calcium carbonate, particulate detritus, and bacteria, which forms a complex optical system. The study of periphyton accumulation, however, is a difficult task due to the erratic behavior that it can show. Several authors have reported detachment of the periphyton accumulated on artificial substrata. Mc Intire & Phinney (1965) found correlations between dislodgement peaks and high silt load in natural streams. They concluded that especially filamentous algae were sensitive to the scouring effect of silt and Eichenberger & Wuhrmann (1975) observed spontaneous dislodgement from the substrata in some of their experiments. Due to the particular behavior of algae in their attachment to the control sections in canal it would have been a good approach to carry out this kind of experiments.

The problems of these experiments as it was mentioned before plus the difficulties of setting periphyton studies in canals with no permanent water plus the little time available to perform a complete periphyton study it was decided, at this stage, just to gather some information on algae development by sampling canal water and analyzing chlorophyll content in order to estimate the amount of algae present in those canals.

The concentration of photosynthetic pigments is very much used to estimate the biomass of phytoplancton. Green plants contain chlorophyll "a", which constitutes approximately 1 to 2 % of the dry weight of plankton algae. In addition , there are other pigments present in phytoplancton, such as: chlorophyll "b" and "c", xantophylles, phycobilins and carotenes.

Chlorophyll "a" is the preferred marker to estimate algae biomass, which can be determined by means of three methods: spectroptometry, fluorometry and high performance liquid chromatography (HPLC).

A useful marker to establish water quality is the ratio biomass-chlorophyll "a". In non-contaminated water, plankton is mainly autotrophic (algae with chlorophyll). As the amount of organic mater increases, so does the heterotrophic portion.

The autotrophic index (A.I.) relates changes in the specific composition of plankton with the variations in water quality. It is defined as:

$$A.I. = \frac{\text{weight of ash - free organic matter mg/cm}^3}{\text{chlorophyll "a"}}$$

The A.I. normal values range between 50 and 200. Higher values indicate poor water quality.

MATERIALS AND METHODS

Three sampling locations where selected:

* Main Canal left bank, fifty meters downstream from the Tiburcio Benegas diversion dam.
* San Martín Canal by Chileno Herrera street.
* Montecaseros canal a few meters before the Chivilcoy fourth tertiary canal.

In order to determine chlorophyll levels, prior to pigment extraction with acetone in acquous solution, the spectrophqtometric method was used. The extract absorbency was measured at 630, 664, 647 and 750 nm.

RESULTS

SAMPLE	CHLOROPHYLL mg/l			Volatile Solids mg%ml	A.I.
	"a"	"b"	"c"		
1	2,11	2,11	2,13	0,03	$1{,}42 \times 10^{-7}$
2	0,60	0,70	0,69	0,02	$9{,}48 \times 10^{-8}$
4	---	0,357	---	0,02	---

This work started in the agricultural cycle 97/98, and only one sampling has been performed so far. This sampling corresponds to September when temperatures are not favorable for the development of algae. Therefore, it will be necessary to determine chlorophyll concentration throughout the whole irrigation period in order to establish if algae biomass increases during the summer months and if the A.I. indicates poor water quality.

REFERENCES

- Bold, H.C. and others. Morphology of Plants and Fungi, 5th ed. (Harper, 1986).
- Cork, Barbara. Plant Life (EDC, 1984).
- Eichenberger, E. & Wuhrmann, K., 1975. Growth and photosynthesis during the formation of a benthic algal community. Verh. int. Verein. Limnol. 19: 2035-2042.
- Huxley, Anthony. Plant and Planet (Penguin, 1987).
- Losee, R.F. & Wetzel, R.G., 1983. Selective light attenuation by the periphyton complex. In Wetzel, R.G. (Ed.), Periphyton of freshwater ecosystems. Dr. W. Junk Publishers, The Hague, The Netherlands, pp. 89-96.
- McIntire, C. & Phinney, H.K., 1965. Laboratory studies of periphyton production and community metabolism in lotic environments. Ecol. Monogr. 35: 237-258.
- Otto, Naman. Division of Research, Office of Chief Engineer. Bureau of Reclamation. 1970. Algaecidal evaluation and environmental study of mat producing blue-green algae. Denver, Colorado.
- Pitlo, R.H. & Dawson, F.H., 1990. Flow-resistance of aquatic weeds. In: A.H. Pieterse & K.J. Murphy (eds). Aquatic weeds. Oxford University Press, 1990, pp. 74-84.
- Prescott, G.W. University of Montana. How to know the freshwater algae. 3rd Edition. Wm. C. Brown Company Publishers. Dubuque, Iowa.
- Raven, P.H. and others. Biology of Plants, 4th ed. (Worth, 1986).
- Salisbury, F.B. and Ross, C.W. Plant Physiology, 3rd ed. (Wadsworth, 1985).
- Smedema, L.K. & Rycroft, D.W., 1983. Land drainage. Batsford Academic and Educational Ltd., London.
- Department of the Interior. Water and Power Resources Service. 1980. Aquatic pests on irrigation systems. Identification guide. 2nd Edition. Washington D.C.
- Yaron, D., 1981. Salinity in irrigation and water resources. Marcel Decker, Inc. New York.