AGMIN NEWSLETTER No. 233

Reduced Toxin Released by Early Treatment of a Blue-Green Algal Bloom

Many species of blue-green algae contain toxins, which can be released into water when the bloom collapses and decays (*Refer to Newsletter No. 222 for list of species*). In Australia, the two main toxic genera are Anabaena and Microcystis.

The growth rate of planktonic algae, such as blue-green or Cyanobacteria, can be quite rapid under favourable conditions, leading to doubling rates in cell numbers of 3 – 4 days (*Refer to Newsletter No. 225*). This means that an initial cell count of 100 cells/mL will grow to at least 24,000 cells/mL in 30 days (doubling time = 4 days); of these some 20 % will be senescing or dying, thereby leaking their toxin into the water column. This number of "leaky" cells, (4,800 cells/mL) will release up to 1 µg/L of Microcystins into the water (extra-cellular toxins), thereby reaching the WHO Guideline Limits for drinking water in 30 days. If this bloom is not controlled, the cell number will continue to increase (doubling time is 4 days), and the extra-cellular Microcystin toxins will similarly increase, reaching 2 µg/L in 34 days, 4 µg/L in 38 days and 8 µg/L in 42 days. This exponential growth in extra-cellular toxins is illustrated in Figure 1, showing that the toxin concentration in drinking water will exceed the WHO Guidelines after 30 days. A Risk Assessment should be carried out to determine whether the risks to humans and to animals can be reduced as low as reasonably practical, by applying a cost-justification process (*Refer to Newsletter No. 230*).

One pro-active management decision is to control the continued growth of an algal bloom by applying Cupricide at an earlier stage of the growth cycle. Using the same scenario as above, the algal bloom will grow to 5,000 cells/mL in 22 days. If Cupricide is applied at this stage, the total cell count will be destroyed and all the toxins will be released into the water, producing a Microcystin toxin concentration of 1.0 µg/L (within the WHO Guidelines). The extra-cellular toxins will then be degraded and removed from the water by several processes including:

1) Photo-degradation in sunlight,
2) Microbial degradation by bacteria,
3) Physical adsorption on clay particles and humic substances,
4) Chemical degradation by alkaline hydrolysis or oxidation.

A toxin degradation rate of 15 % per day (half-life of 5 days) will reduce the liberated toxin concentration to 0.04 µg/L after 20 days. Even if the algae were to redevelop after Cupricide application, the total toxin concentration in water will not exceed the WHO Guidelines until another 26 days or more. If necessary, a second application of Cupricide will ensure that the algae cell numbers will not exceed the Epidemiology Guideline of 5,000 cells/mL and the WHO Guideline of 1.0 µg/L Microcystin. This course of action is illustrated in Figure 2, which shows that an application of Cupricide at day 22 (5,000 cells/mL, 1.0 µg/L Microcystin) will not exceed the WHO Guideline. Any regrowth of algae can be controlled by a second addition of Cupricide at day 48, giving total protection for more than 75 days. This model also takes into account the degradation of the released Microcystin toxin between days 22 – 48 and days 48 – 75.

Pro-active management of algal blooms (taking action before significant cyanobacterial proliferation has occurred) is preferable to reactive or crisis management, which puts controls in place after significant algal blooms have developed. The risks to the health of humans and animals will be significantly reduced by this pro-active approach.

Figure 1.

Untreated Algal Bloom (Extra Cellular Toxins 20%)
5,000 cells/mL = 1.0 µg/L Microcystin;
Growth Rate = 20 % per day (µ = 0.25);

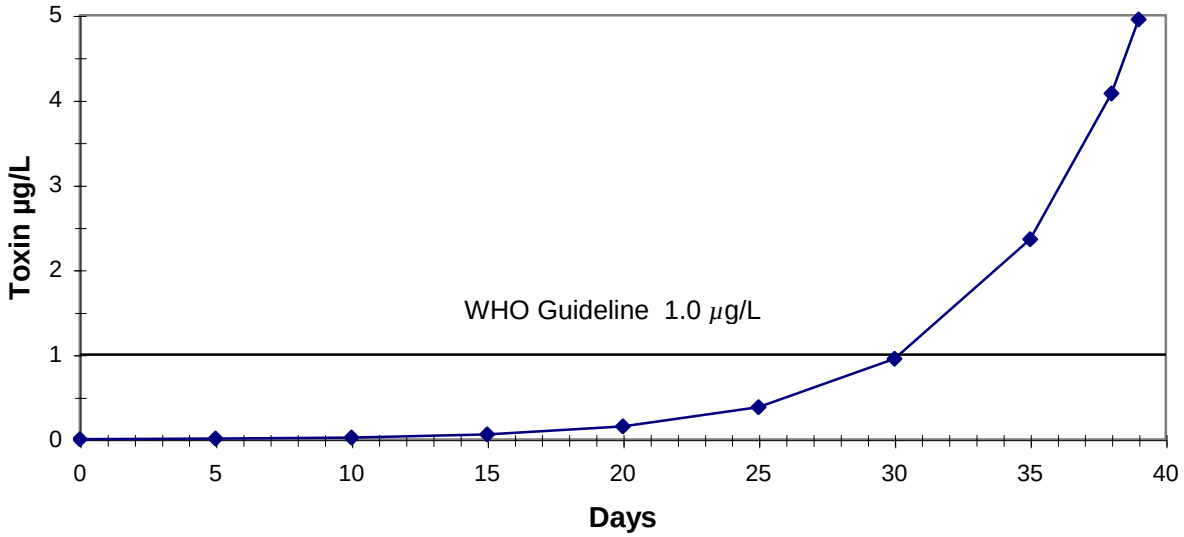
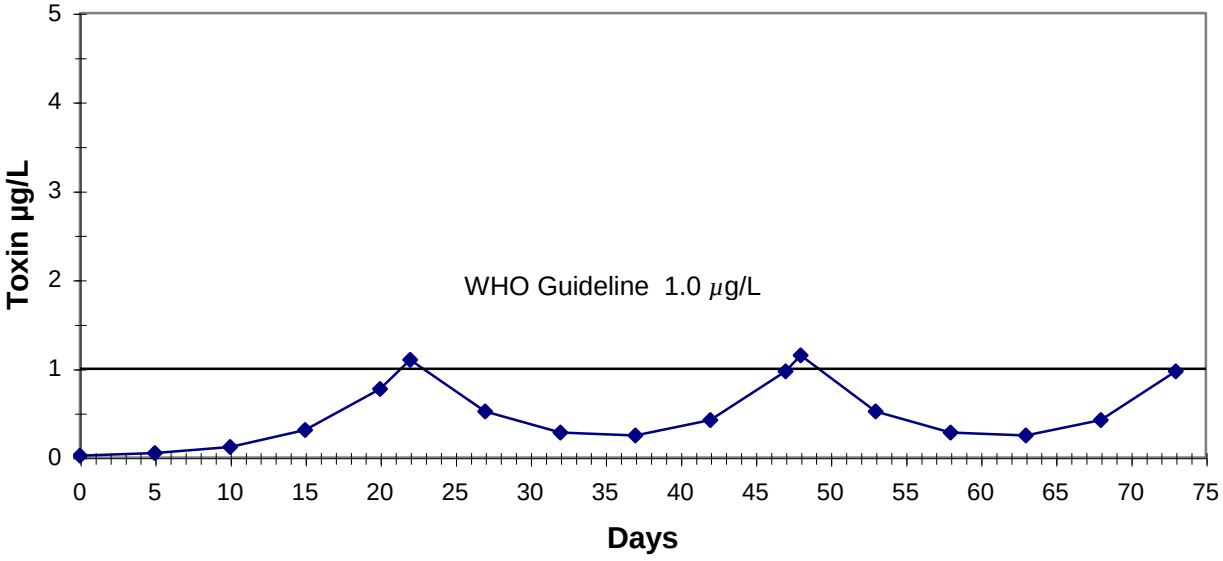


Figure 2.

Cupricide Treated Bloom (Extra Cellular Toxins 100%)
5,000 cells/mL = 1.0 µg/L Microcystin;
Growth Rate = 20 % per day (µ = 0.25);
Toxin Degradation = 15 % per day.



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