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Water Quality Matters

Copper Treatments for Dugouts

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INTRODUCTION

Algae and aquatic plant growth are common problems in farm dugouts or ponds because the water is rich in plant nutrients. Sometimes copper sulphate is added to dugout water to control algae growth. At certain concentrations, copper is toxic to algae, plants, and many other organisms. Green algae growth sometimes increases several weeks after treatment. This occurs because too many beneficial organisms are also killed. For example, zooplankton eat green algae, keeping their populations at lower levels. When too many zooplankton are killed, green algae re-establish and soon grow to a high population density, since they have less predator organisms to limit their growth. Copper treatments always disrupt biological life in a dugout ecosystem.

Copper treatments must therefore be used very carefully, and only when no other treatment option is practical. Follow applicable regulations and restrictions. Even with treatment, it is not possible to keep nutrient-rich dugouts free of algae and aquatic plant growth.

Copper treatments may be an option for control of **cyanobacteria**. Water should never be used for human or animal consumption immediately after a copper treatment.

CYANOBACTERIA

A serious problem exists when cyanobacteria grows in dugouts. Some species of cyanobacteria are visible to the naked eye, and may resemble green algae with a bluish tinge. They are sometimes referred to as blue-green algae, but they are not algae - they are bacteria.

Some species of cyanobacteria produce liver or nerve toxins. These toxins may kill animals that drink the water. Unfortunately it is not a simple task to test for toxins in the water. It is therefore critical to control the growth of cyanobacteria in any water supply used for human or animal consumption.

Spraying copper to control cyanobacteria **is very effective**

Cyanobacteria identification is possible. Trained specialists visually identify the presence or absence of the bacteria using a microscope. Many commercial laboratories can identify whether or not cyanobacteria are present in a water sample. Any water sample taken for cyanobacteria identification should be kept cool and analysed within 24 hours of being collected.

If a cyanobacteria problem is discovered, properly timed and applied copper treatments may be used to control growth.

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HOW DOES IT WORK?

Copper (Cu) is a metal ion. Very small amounts of copper are essential for plant and animal nutrition. Some green algae thrive when copper is available as a micronutrient at concentrations of 0.03 mg Cu/L. Copper is toxic at high concentrations. For example, copper is poisonous to Rainbow trout at concentrations of approximately 0.04 mg Cu /L. Drinking water is regulated well below toxic levels for humans. The Canadian guideline is a maximum copper concentration of 1.0 mg Cu/L to avoid taste and staining problems.

Most water treatment products for algae control use copper as the active ingredient. The most common formulation is copper sulphate, often called **bluestone**. Many other commercial products are also available, but they rely on the same active ingredient. Some have additives to keep the copper in solution for a longer time period, increasing the treatment effectiveness.

Copper is toxic to most types of cyanobacteria at concentrations ranging from 0.06 to 0.25 mg Cu/L. When cyanobacteria are killed by a copper treatment, toxins may be released in high concentrations. Before using the water as an animal drinking water supply, wait at least 14 days after treatment to allow time for potential toxins to degrade.

Copper treatments work by dissolving copper into the water. When dissolved into solution, free copper ions will kill the target organisms - cyanobacteria. The treatment will also kill or poison beneficial non-target organisms such as zooplankton and fish. Eventually, the copper will precipitate, settle, and accumulate in the sediment. Over time, copper and other nutrients such as phosphorus, will recycle from the sediment into the water column in micronutrient concentrations, especially in dugouts that are not aerated. Nutrients flowing into the water from runoff add to the problem and promote new algae growth, and recurring problems with cyanobacteria. This is a natural cycle for all dugouts.

SAFETY

Federal and provincial regulations permit the use of copper treatments in dugouts and farm ponds. In Canada, chemical pest control for plants, which includes algae and cyanobacteria, is regulated by the Pest Management Regulatory Agency (Health Canada).

Registered copper products must be applied in accordance with product labelling. Labelling specifies restrictions both to protect the environment, and to ensure that the treated water is safe for its intended use (irrigation, livestock watering, domestic water, and drinking water).

TIMING OF TREATMENT

Inspect dugouts visually at least once each week during open water season (April to October). Algae and cyanobacteria blooms can grow and collapse within a period of one to two weeks. Growth is faster when water temperature starts to rise after a period of warm, sunny weather.

The best and safest time to treat a dugout with copper is at the beginning of a bloom. This results in better control. Do not treat dugouts more than two or three times each year.

The following table lists the optimum conditions for a successful copper treatment. Never compensate for poor conditions by increasing the chemical dose. Overdosing can create serious water quality problems and make the water unsafe or even dangerous for use.

Table 1: Optimum Conditions for Successful Copper Treatment

Ambient Condition	Desirable Range
Water pH	7 to 8
Water Alkalinity	50 to 150 mg/L
Water Temperature	>15°C
Weather	sunny, warm, no wind

CHEMICAL SELECTION AND DOSE

Use only registered products for dugout treatment. Copper products registered in Canada are listed in **Table 2**. Apply at safe doses, being careful not to exceed the label rate. Read the label and product literature for any specific restrictions on product use. For example, some products may not be registered for use in drinking water or livestock water supplies.

Copper is found in a variety of commercial products. Each product uses the same active ingredient, copper (Cu), but the concentration may vary. Sometimes additives are also incorporated.

For dugouts, target treatment of the top 1.0 m of water. This is a similar strategy used in lake treatments. Algae and cyanobacteria require light to grow, and they will tend to live in the top 1.0 m of the dugout water column. A dose of 0.06 to 0.25 mg Cu/L will control cyanobacteria. The maximum recommended target dose in Table 2 is 0.25 mg Cu/L for all dugouts.

TREATMENT METHODS

Copper treatments are easily applied. The following methods work well for dugouts and farm ponds. Follow safe handling practices. Wear protective clothing, boots, gloves, and goggles. Use air filter masks if the chemical is in powdered form. Removal of dead floating algae or plants before application will improve treatment effectiveness.

Spraying Method
(the most effective)
See photo, front page

Dilute the required amount of copper product into a chemical spray tank. Spray the entire surface area of the dugout. This application is most effective when sprayed from a boat. As an example, treatment of a dugout surface area of 50 x 20 m requires 0.5 kg of dry copper sulphate. The 0.5 kg can be mixed with water into a 10 L hand pump chemical spray tank. The chemical is then sprayed over the entire surface area by rowing back and forth in a grid pattern. If the spray is set for a fine mist, it can be applied more than once over the surface area to deliver the required dose.

Use protective gear such as gloves when handling copper products

Sock/Bag Method
(granular dry chemical only)
See photo, page 5

Weigh the required amount of dry copper before treatment. Tie a rope to one end of a nylon sock (or burlap bag). Insert a fist-sized rock in the sock for weight. Fill the sock with the required amount of dry copper. Tie another rope on the other side of the sock. Two people can apply the chemical by dragging the sock back-and-forth in a grid pattern over the entire water surface area. As an example, 0.5 kg of dry copper sulphate will dissolve when treating a surface area of 50 x 20 m. (For large dugouts, drag a burlap bag behind a boat.)

Spot Treatment Spraying Method

Spot treatment is ideal for intermittent treatment. Add 5 mL (one teaspoon) of dry copper sulphate into 5 L of water. Spray areas where cyanobacteria are starting to grow. Spot treatment may be especially useful when a breeze concentrates cyanobacteria on one shore.

The chemical dose targets treating the top 1.0 meter volume of water

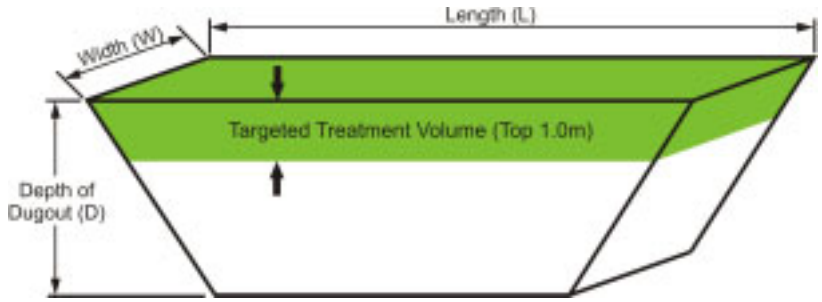

Table 2 - Equivalent copper doses for cyanobacteria control - chemicals registered by Pest Management Regulatory Agency (Health Canada, 2001)

This table may be used for all dugouts deeper than 2.0 m deep.
Follow regulations and labelling requirements.
Measure the length and width of the dugout water surface area, in meters.
Calculate the Targeted Treatment Volume (Top 1.0 m): - multiply L x W x 1.0m depth x 1,000 L/m3 = Volume, in Litres.
The Volume, in Litres, is the Targeted Treatment Volume of the dugout to be treated.
To calculate the chemical needed, refer to the shaded values. These are equivalent doses to treat a Reference Dugout Targeted Treatment Volume (Top 1.0 m) of 1.0 million Litres.
Pro-rate the amount of chemical required for the Targeted Treatment Volume of the dugout to be treated. Example 1 is pro-rated by multiplying by 1.8 and Example 2 by 3.0. Remember - the volume to be treated is the top meter only, not the total volume.

Dugout Examples (L x W x D in meters)	**Reference Dugout 50 x 20 x 3.5**	Example 1 60 x 30 x 4.5	Example 2 100 x 30 x 6.0
Targeted Treatment Volume (Top 1.0 m)	**1.0 million L**	**1.8 million L**	**3.0 million L**
Top 1 m Treatment Dose, as Cu	0.25 mg Cu/L	0.25 mg Cu/L	0.25 mg Cu/L
TeckCominco Cupric Sulphate Pentahydrate; 25.2% Cu by weight	1.0 kg	1.8 kg	3.0 kg
Phelps Dodge Triangle Brand copper sulphate 25.2% Cu by weight	1.0 kg	1.8 kg	3.0 kg
Nalco Cuprose granular; 19.1% Cu by weight	1.3 kg	2.3 kg	3.9 kg
Algi-Boss, liquid; 5.0% Cu by weight (Density ~1.2)	4.1 L	7.4 L	12.3 L
Polydex, liquid; 5.0% Cu by weight (Density ~1.2)	4.1 L	7.4 L	12.3 L
If fish are present, follow all product restrictions.	Reduce by 60%	Reduce by 60%	Reduce by 60%

Two people drag a sock of copper back and forth over the entire surface area

LIMITATIONS

Cyanobacteria can produce lethal toxins in water. When copper is used to treat a dugout, assume that toxins have been released by the decomposing bacteria.

Wait at least 14 days after a copper treatment, before using the water as a drinking water supply for humans or livestock. Toxins should be broken down or inactivated during this time period.

Another negative impact of copper treatments is oxygen depletion. Cyanobacteria, algae, plant, and other aquatic organisms killed by copper will consume oxygen during decomposition. This may rapidly deplete oxygen, leading to suffocation of fish, and cause a variety of other water quality problems. After treatment copper will accumulate in the sediment, and may also cause problems for beneficial aquatic organisms living in or near the sediment. Continuous, year-round aeration systems, with the diffusion device installed at the bottom of the dugout, will assist in dealing with some of these adverse effects.

Copper treatments will not keep nutrient-rich dugouts free of plants and algae. Some researchers have even reported that algae and cyanobacteria may build up a resistance to copper after repeated treatments.

Copper treatments should not be used when dugout alkalinity is less than 50 mg/L, since the toxic impacts may be too severe on other organisms. Conversely, copper treatments are not very effective if the alkalinity is over 200 mg/L, or if the pH is over 8.

Copper should never be overdosed, overused or unnecessarily applied to any water body. A dugout should not be treated more than two or three times per year.

THE BIG PICTURE

Copper treatments are a temporary solution to problems with cyanobacteria. The treatment does not deal with the root problem for the growth of cyanobacteria, algae, and plants. Prairie dugouts experience prolific algae growth because the water is nutrient-rich. Typically, dugouts have very high phosphorus concentrations which serve as a nutrient for cyanobacteria, algae, and aquatic plants. Therefore, even after effective copper treatment, cyanobacteria and algae problems will recur at a later date.

The best plan to minimize cyanobacteria, algae, and aquatic plant problems incorporates good watershed management. The goal is to prevent nutrient inputs into the water. Nutrient sources include phosphorus, nitrogen, animal waste, fertilizers, soil particles, and silt. Each of these act as a fertilizer for algae and aquatic plants. An example of watershed management is remote livestock watering.

Best Management Practices (BMPs), such as grassed buffers and fencing to exclude animals (including livestock) from water, can minimize external phosphorus inputs from soil, fertilizer, and animal manure. Perimeter dyking around the dugout combined with an inlet control structure can be used to divert silt-laden or nutrient-rich runoff water away from the dugout.

A 10 L hand pump spray applicator is ideal for small dugouts

A secchi disk showing dugout water before and after a successful treatment of one type of cyanobacteria

Well-designed, continuous, year-round diffused aeration at the bottom of the dugout can minimize the natural recycling of phosphorus from the sediment. Other methods such as remedial dugout coagulation treatment will remove phosphorus from the water column, and can minimize the potential growth of cyanobacteria.

Well-managed dugouts may not require any copper treatments, and thereby avoid the negative impacts caused by the treatment. Effective management of the watershed and dugout will always lead to improved water quality.

For more technical information, refer to "A Technical Guide to Copper Treatments for Dugouts", available from PFRA or our website.

For further information on rural prairie water quality and treatment technology:

- read the other publications in PFRA's **Water Quality Matters** series;
- visit the PFRA website at www.agr.gc.ca/pfra
- see the **Water Quality Matters** publication "Algae, Cyanobacteria, and Water quality"
- read Prairie Water News available from PFRA, or on the internet at www.quantumlynx.com/water; or
- **contact your local Prairie Farm Rehabilitation Administration Office** (PFRA is a branch of Agriculture and Agri-Food Canada).

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