Reducing Algal Blooms From Agricultural Run-Off

South Dakota farmers are working toward reducing algal blooms in lakes and creeks.

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Algal blooms in South Dakota

Are algal blooms an issue in South Dakota? According to a report from the South Dakota Department of Environment and Natural Resources in 2018, 69% of the lakes they assessed were at high risk or had algal blooms. Algal blooms, specifically blue-green algae blooms in lakes and creeks occur when excessive nutrients like phosphorus cause an over-population of algae. This process is called eutrophication. When the algae reach the end of their life-cycle, their decaying bodies accumulate on the surface of waters (typically seen as green patches) (figure 1). This blocks sunlight, preventing it from reaching aquatic plants. In addition, a significant amount of effort is required by microorganisms to decompose the blue-green algae. The microorganisms deplete much of the available oxygen during the decomposition process. This depletion of oxygen negatively impacts other plants and aquatic animals in the lake. The result is hypoxia which can negatively impact the aquatic ecosystem.

Figure 1
Photo courtesy of the Mitchell Daily Republic
Algal blooms on Lake Mitchell make the water hazardous for humans and animals.

Environmental, human health, and economic effects

Certain types of algal blooms can cause severe damage to the environment and human health. If a person or animal drinks or swims in water that is affected by the harmful algal blooms, it can cause serious health problems including rashes and respiratory, neurological, stomach and liver issues. The abundance of these algal blooms also has harmful effects on South Dakota's drinking water. Algae can give the water an unpleasant odor and taste, which can be very costly and difficult to remove by water treatment facilities.

Other types of algal blooms can create toxins which can kill fish and other aquatic animals. This can result in the disappearance of desirable fish such as trout and increase the number of undesirable ones such as carp. This leads to reduced fishing, swimming and boating activities, which decreases tourism throughout the state. Real estate losses also occur due the unpleasant appearance and odor of algal blooms.

Sources and solutions

Algal blooms in lakes and creeks have been primarily to both point and non-point pollution sources such as storm water, wastewater, and agriculture. When polluted water from cities (for instance sidewalks and roads) and wastewater treatment plants is not treated appropriately, high concentrations of phosphorus (P) and nitrogen (N) can be discharged into waterways. In agriculture, nitrogen and phosphorous are used to fertilize crops. Over-fertilization and/or improper application methods can result in some of these fertilizer nutrients reaching waterways such as ditches, creeks and rivers that flow into lakes.

Farmers are adopting practices to minimize nutrient runoff from their farming operations. For instance, some are applying phosphorus fertilizer at very low rates that maintain relatively low soil test levels while at the same time incorporating strategies that enhance the phosphorus uptake and efficiency by crops. This combination of actions prevents yield loss. Phosphorus use efficiency by crops can be improved through the use of fertilizer placement in proximity to the seed (side-band and/or pop-up). Nutrient uptake efficiencies can also be enhanced by arbuscular mycorrhiza fungi (AMF). These fungi can help the plant take up 3 to 5 times more nutrient than crops without mycorrhiza associations.

Crop rotation, tillage and other management factors can impact the level and benefits of mycorrhizae. Promoting interactions between plant roots and AMF may allow for higher yield levels at reduced P solubility. This could result in reducing the potential for water pollution from fertilizer nutrients specifically phosphorus.

Dakota Lakes Research Farm Study

The Dakota Lakes Research Farm began a program over 20 years ago to lower soil test phosphorus levels on the irrigated portion of the property that was in proximity to the Missouri River. Phosphorus soil tests used to make fertilizer recommendations are designed to provide an estimate of phosphorus solubility. The Olsen, Bray, or similar tests do not measure total phosphorus present, they estimate solubility. Having an estimate of phosphorus solubility is important because soluble phosphorus is the form taken up by (available to) plants. It is also one of the forms that moves to lakes and rivers with runoff water.

The hypothesis was that the use of no-till management that encourages healthy AMF communities, along with the placement of phosphorus fertilizers in proximity to the plant roots would be able to supply adequate nutrient to plants even though P solubility of most of the soil was low. Some preliminary studies have indicated that this may be true, but a more robust analysis is needed.

Funding provided by the South Dakota Nutrient Research and Education Council is allowing for a more comprehensive look at this issue. There are actually two parts of the study. Both are being done in a rotation of Corn-Corn-Soybeans-Wheat/CC-Soybeans. Olsen soil test levels are approximately 5 ppm. One part of the study evaluates crop and soil responses when higher levels of P fertilizer (100 and 200 lbs. of MAP/acre) is applied to raise soil test levels as compared to treatments where only maintenance levels are applied at seeding. Plant nutrient levels during vegetative growth, yield, and other parameters are being measured along with phosphorus movement with surface runoff and deep movement of P in the soil. In a companion study phosphorus is applied during seeding either with the seed or on the soil surface. A similar set of parameters is being measured. Focusing on the wheat year with this part of the study, allows following it through to the subsequent cover-crop. The long-term goal is to be able to make fertilizer phosphorus recommendations that minimize off-site movement of the nutrient while also maximizing P utilization efficiency and crop yields. Much of the phosphorus calibration work that has been done previously involved tilled systems with few if any AMF. In no-tillage systems, plants absorb nutrients differently, which means it may be necessary to adjust the soil tests for different types of soil management systems. We believe we can use lower soil test levels in no-tilled systems because the biology helps the plant to obtain phosphorus.

Reference United States Environmental Protection Agency; Nutrient Pollution

Pirner, Steven M., The 2018 South Dakota Integrated Report for Surface Water Quality Assessment; South Dakota Department of Environment and Natural Resources

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