Nova Scotia Agriculture and Fisheries | Nova Scotia Agricultural College | Horticulture NS Nova Scotia

fact sheet

What You Should Know About Irrigation Water Quality Safety

Introduction

Nova Scotia often experiences prolonged periods of dry weather during most growing seasons. Therefore supplemental irrigation is required to alleviate moisture stress and prevent significant crop yield reductions. Frost protection that utilizes the latent energy in irrigation water is also required for some frost sensitive crops, such as strawberries and apples. As a result, many Nova Scotia fruit and vegetable producers rely on effective irrigation management to help guarantee high quality crops.

Irrigation Water Quality

Most producers, in Nova Scotia, utilize surface water supplies rather than groundwater for irrigation due to the lower operational costs. Also, groundwater is not available in all regions in sufficient quantities to support typical irrigation volume requirements.

The inherent difficulty is that surface water resources are generally more susceptible to microbial contamination than groundwater supplies. Sources of surface water contamination can include agricultural run-off, cattle access, polluted floodwater, municipal sewage treatment facilities, wildlife, on-site treatment systems (eg. septic fields) and various types of processing plants.

These guidelines are currently being supported in Nova Scotia by the Nova Scotia Department of Environment and Labour. Often, surface water sources exhibit poor water quality when irrigation is needed most. Unfortunately, some producers are forced to use water containing high fecal coliform levels for irrigation due to the unavailability of alternative water sources. Therefore, an understanding of the risks associated with irrigation requires a fundamental understanding of microbiology. The Canadian Council of Ministers of the Environment have placed a fecal coliform limit of 100 CFU's (colony-forming units) per 100 mL and a total coliform limit of 1000 CFU's per 100 mL for irrigation water.

Microbial contamination introduced through sprinkler irrigation may affect the surface of a crop for varying periods of time. The risk is increased when the irrigated crop is consumed raw and sometimes unwashed.

Microbial Contamination of Water Resources

Microorganisms are extremely abundant in the environment where they assist in the decomposition of organic matter and are key to maintaining soil fertility. Only a few types have the ability to cause illness. These microbes are referred to as **pathogens**. Microbial pathogens in the form of bacteria, protozoa and viruses commonly occur in human and animal excrement.

Bacteria

Bacteria are single celled living organisms, visible only under a microscope. They survive and grow under a variety of conditions. The temperature range at which most bacteria proliferate is between 4°C and 60°C. Bacterial contamination often results from the introduction of fecal material into water supplies. Among the more well known, potentially pathogenic bacteria that enter water systems this way are *Escherichia coli (E. coli), Salmonella* and *Shigella*. As they originate within the intestinal tract of animals, they are referred to as **enteric** bacteria.

Escherichia Coli is a normal resident of the intestinal tract of healthy warm-blooded animals. There are hundreds of strains of *E. coli*, most of which are harmless; but, a few types do cause illnesses such as gastroenteritis. One such strain, *E. coli* O157:H7, produces a powerful toxin that can cause severe illness in humans including disruption of kidney function.

Salmonella occurs mostly in the intestinal tract of animals, but occasionally is found elsewhere in the body. Of the more than 1200 types of *Salmonella* that exist, only a limited number of these have been associated with human illness. Illnesses include typhoid fever, septicemia and food poisoning.

Shigella, also known as bacillary dysentry, causes intestinal ailments of various severities. *Shigella* bacteria easily pass from one infected person to another orally or, less commonly, are transmitted by food and water.

Protozoa

Protozoa are larger than bacteria and can be either unicellular or multicellular. They exist as thick-walled, chlorine-resistant, cysts or oocysts in the environment (water and soil). They require a warm-blooded host for reproduction and growth. Due to their size, protozoa can be removed from water by filtration, but this is an expensive process.

Two of the most common pathogenic protozoans are *Giardia lamblia* and *Cryptosporidium parvum*. *Giardia lamblia* is carried by domestic and wild animals and causes a type of gastroenteritis known as "beaver fever". *Cryptosporidium parvum* is found in the feces of infected calves and humans. Infections due to either of these microbes is unlikely to be fatal to a healthy adult but serious illness can occur in the sick, immuno-suppressed, elderly and the very young.

Viruses

Viruses are parasitic microorganisms that require a host organism to reproduce. Human pathogenic viruses will not reproduce outside the human body. Viruses are extremely small, can pass through filtration membranes and can only be visualized with powerful electron microscopes.

As a result of their host specificity, waterborne viruses affecting humans are derived solely from humans. It is currently believed that viruses present in animal manure do not pose a major health threat. Examples of waterborne viruses include Hepatitis A and E, Norwalk virus and poliovirus. While most foodborne viral infections result from poor handling practices, instances of water-associated illness have also been recorded.

Indicator Organisms

Testing water for individual pathogens is time consuming, technically demanding and depending on the methodology used, can be expensive. A more practical approach is to test for species of bacteria that signal the presence of undesirable microorganisms and/or potential human pathogens. Such microbes are referred to as indicator organisms.

Coliform bacteria have been used as an indicator of the general bacterial quality of water and the possible presence of human pathogens for over a century. Coliform bacteria are always present in the intestinal tract in large quantities and millions of them are excreted in fecal material.

Coliforms are a broadly defined group of bacteria that occur naturally in the soil and in decaying organic matter, as well as in the digestive tract of warm-blooded animals. Coliforms survive longer in water than most bacterial pathogens and are relatively easy to detect and quantify. If coliform bacteria are not detected in a water supply, then it is reasonably safe to conclude that the presence of pathogens is unlikely. The presence of coliform bacteria does suggest the possibility of fecal contamination and further tests have to be conducted in order to establish whether such is indeed the case.

To enable this possible fecal contamination to be determined, coliforms are further divided into two groups: **total coliforms** and **fecal coliforms**. Total coliforms refer to the entire group of coliform bacteria, regardless of origin, whereas fecal coliforms originate only in the intestines of warm-blooded animals.

Fecal coliforms are the most commonly used indicator microorganisms for health risk assessments. They are characterized as being able to ferment lactose at 44.5°C. *E. coli* is the most frequently identified fecal coliform, while

fecal *Streptococci* are a non-coliform type of bacteria that is also used in this regard. A total coliform test is appropriate for the analysis of drinking water since it must be free of all coliforms. Fecal coliforms, however, are a more appropriate test for monitoring natural surface water or groundwater systems.

Risk Assessment

One should be aware of the potential for microbial contamination of irrigation water supplies. Adjacent agricultural activity, wildlife and the inappropriate disposal of human sewage can all cause some level of contamination. Therefore, it is important to frequently test irrigation water supplies. Standard procedures for water sampling in Nova Scotia, however, have yet to be developed. Bacterial levels can fluctuate over time, as well as between sampling locations. Obtaining one test that is free of fecal coliforms does not necessarily indicate that the water supply is not contaminated.

Collecting replicate samples is essential for more accurately determining the microbial quality of a water supply. A good "rule of thumb" is to base the evaluation on the mean coliform count, whether fecal or total, obtained from a minimum of five samples that have been taken over a 30-day period. Water samples should be taken at mid-depth. In the case of flowing water, low flow areas and dead zones should be avoided.

In Nova Scotia, most hospitals and a number of private and government laboratories perform coliform analyses. The time taken to get sample results depends on the testing format used. Samples, collected in appropriate containers, must be kept cool and delivered to the laboratory the same day they are collected. Many laboratories may only accept samples on certain days of the week (eg. not on Fridays or weekends) and therefore it is best to inquire beforehand.

Practices for Minimizing Risk

Trickle or drip irrigation systems should present a lower risk for potential contamination of crops compared to overhead spray irrigation. This is due to the lower chance of contact between water and the crop itself. As well, irrigating "ready-to-eat" crops with contaminated water near the time of harvest increases the risk of foodborne illness.

The extent to which waterborne micro-organisms survive on plants or in the soil is not well known. Increasing the time between irrigating and harvesting lowers the risk of contamination. Solar or ultraviolet radiation can naturally provide partial treatment of contaminated water on crop surfaces. It is also important to ensure that the irrigated produce is thoroughly dry prior to harvest since microorganisms tend to proliferate in moist environments.

For water supplies that consistantly have coliform counts which exceed environmental guidelines, it may be worthwhile to investigate how the water became contaminated and put remedial measures in place. The difficulty is that these sources may be from an extended area. Other options include alternative water sources or the possibility of implementing an on-site disinfection (eg. chlorination, ultraviolet or ozonation) system.

It is essential to keep detailed records of the farm's activities, such as water testing, irrigation scheduling and harvesting. Should a foodborne illness occur in your region, good record information can show that steps were taken to reduce the likelihood of it originating within your operation.

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Winter 2002