Are Your Plants Drinking Dirty Water?

C.C. Powell

When it comes to keeping your plants healthy, clean water may be your secret weapon. The only question is: Which method(s) should you use to get clean water?

Consider these facts that have recently come to light:

1. More and more nurseries are using recycled irrigation water and producing situations of more and more water contaminated with plant pathogens that can cause diseases. You probably knew this, but thought it was a problem other nurseries had.

2. Virtually all growing facilities with ebb-and-flood irrigation systems are challenged with contaminated water.

3. Irrigation water can contain 30 or mores types of pythium, many phytophthora species, fusarium species and thielaviopsis.

4. The ralstonia bacterial blight on geranium is a quarantine problem primarily because the pathogen is thought to spread so easily in water, including irrigation water.

5. The old standby water treatment, chlorine, has recently been shown to kill pythium spores only at levels that may damage crops. (We'll talk more about this later.)

I decided to start this article with the above statements in hopes of having them serve as a wakeup call. Dirty water is a real problem for all growers to think about.

One solution to the dirty water problem is to not use recycled water for irrigation. When growers use well water or city water and don't recycle any of it, I never see a problem with contamination. The same can be said for those watering crops with reverse-osmosis water. With pond or river water that isn't recycled, there can be problems, but that's pretty rare. Some growers store and use rainwater only for irrigation of some or all of their crops. If you store it so that no runoff water gets into it, rainwater will remain free of pathogens.

But water recycling has becoming widespread in North American and European nurseries, for many reasons. Toxic chemical abatement and confinement, fertilizer savings and water conservation are the most commonl advantages. There are three main types of such recycling systems: using water retention and return ponds; using ebb and flood systems; and growing crops in hydroponic systems. All of these irrigation practices are prone to contamination with plant pathogens. Once in the water, the pathogens spread from plant to plant. The details of the behavior of the pathogens vary with which pathogen you're considering; this is a complex matter that I won't deal with here. In this article, I want to give you some broad "brush stroke" ways of dealing with dirty water.

Methods for dealing with dirty water aren't overly complicated. They aren't always cheap and easy to

employ, but they're straightforward.

I've found that many of the methods suggested to sanitize irrigation water aren't properly conveyed to growers. This creates financial waste and failure to achieve the goal of good water sanitation. This is because: 1. Many of the suggested methods don't work on some of the plant pathogens and spore types that may be encountered in the water. 2. Many are installed incorrectly. They don't work because of other parts of the water handling system already in place. 3. Many aren't practical as an investment from a cost/benefit point of view. 4. Research on effectiveness is lacking for many of the methods.

It starts with the source

First things first: Is it a good investment to treat your water to clean it up?

The basic premise of sanitation is "start clean, finish clean." There are several areas to consider here. Are you already starting with clean water? Consider these facts:

• Well water is clean through natural filtration. Deep wells are cleaner than shallow wells.

• Reverse osmosis (RO) water is clean by definition. This has become a well-thought-out, popular system for propagation facilities. It not only ensures clean water, but also ensures good quality water. It can be expensive, but that's relative to the value of crops you're growing. For instance, many propagators use RO water.

• Rainwater, properly stored, is clean. Again, the quality of rainwater makes it ideal for plug production or propagation facilities.

• Small ponds with plastic liners and with no plant debris around the edges will keep even recycled water fairly clean. This is a bit risky, however. Water coming out of such catchment ponds should be filtered before use. This method is used widely in Europe.

Is reasonably clean water good enough? I believe that it's practical to consider that retention ponds can be set up to deliver reasonably clean water. You may not need "zero tolerance" of pathogens in the water. Integrated plant health management practices (IPHM) will control root health if inoculum levels are low in the water. You can set up retention ponds in series so they greatly lower the inoculum potential by the time water is finally drawn off for reuse. Such systems, called dilution systems or step pond systems, are widely used.

In a step pond system, the major part of the inoculum remains in the first runoff pond. It slowly breaks down there. Water is drawn from just below the surface of this pond into a second and then maybe a third pond. If not stored too long in the second pond, this water is fairly clean.

Are you watering dirty plants with clean water? Unless you can clean a growing area reasonably well of pathogens before you begin a crop, cleaning up the water may be a needless expense. It's difficult to properly clean old, dirty greenhouses; ones with earth or gravel floors; those with weeds or old plants "hanging around" and outdoor growing areas.

If you plan to sanitize irrigation water, you must take all precautions to ensure that all plants coming into the greenhouse are as free of pathogens as possible. However, you'll never reach zero tolerance on this point; seed contamination, infected cuttings and diseased pre-finished plants always exist somewhere.

Given all of the above, are you willing to install a truly effective system to clean your water? You need to do your homework. Now would be a good time to seek some outside help. Here are the homework points.

• Any particular system will work for some, but may not be practical for others.

• Costs of installation and maintenance will vary a lot. How much are you willing to spend?

• Sometimes, no well-suited method will be available. In such cases, you'll need to use IPHM.

Filtration methods

Physical methods, as opposed to chemical methods, are always the best way to clean up your water. Physical water sanitation methods are filtration methods. They all have one serious drawback: Filtering restricts the flow rate. This makes these systems okay for smaller greenhouses, but not necessarily practical for large greenhouses. Still, they work so well that they deserve serious consideration by all growers who want to treat their water. I recently dealt with a large grower who considered a slow sand filter with a 2-acre surface area!

The best filtering method is through large sand towers. The method is called slow sand filtration. The towers are 8 to 10 ft. high and 6 to 8 ft. across and filled with relatively coarse sand. Bacteria build up in the top part of the sand and destroy pathogens in the water. In addition, the sand itself filters out pathogens.

For small greenhouses, up to a few acres, one tower is enough. For larger growers, you may need more than one tower. You can filter water into a holding tank over 24 hours for use the next day. The flow rate can be calculated to determine how many or how big your filters would need to be. This water sanitation method is popular in Europe.

There are other kinds of filtration methods. For straight filtering of pathogens, you need very fine filters. You must set these up in series, starting with coarser filters. Even with high pressure, the flow rate is very slow with these systems.

Heat and light filtration

Systems that bombard the water with lethal heat or light energy will sanitize water and are safe on plants. Worldwide, the most common method in this category is momentarily heating the water to 180F and then cooling it back down. These heat exchangers come in various sizes, depending on need. Their big advantages are that they are effective, don't alter the water, are relatively cheap to operate and that they require no holding tanks (see below).

These systems are popular in Europe, but are rarely used here. Since they have to be imported, the initial installation is expensive. When I inquired about the failure to produce them domestically, I was told that there was no call for them. This is a real catch-22! North American growers may not consider these systems because hard water produces scale in the heaters (acidifying the water first can solve this) and they don't work well with turbid (cloudy or muddy) water (minimal prefiltering helps a lot).

Bombarding the water with ultraviolet (UV) light is often mentioned as a worthy water treatment method. To work properly, a very slow flow rate and a thin film of flowing water is a must. It's easy to kill some bacteria and fungi (pseudomonades, erwinia, zoospores of water molds) in this way, but hard to kill many fungal pathogens with thick-walled spores and other bacteria (xanthomonas, fusarium, some pythiums, phytophthoras and thielaviopsis).

Growers in Florida are using UV for killing erwinia in the water. This may be okay, because erwinia is closely related to *E. coli*, a common dairy farm contaminant in milk. *E. coli* has been killed with UV irradiation on dairy farms for a long time.

A new "pulse UV system" is being researched now. This may work better because it gets much more UV energy into the water and will allow for a faster flow rate. Other energy-adding methods, such as gamma rays, haven't been researched enough to be sure they work for greenhouses.

Chlorine, ozone, peroxide and copper

There are several methods for sanitizing water that add substances to the water. These methods work well, but only if carried out precisely. Shortcutting the processes generally make them ineffective. Most work better when combined with prefiltering and acidification of the water.

The most popular method—and the most often incorrectly designed—is chlorination. Chlorination is a holding tank system. This is the key design element that most growers fail to do properly. The proper dose must be put into the water and held there for 30 minutes of oxidation time. Many try to bypass the holding time with higher doses of chlorine. This invites phytotoxicity. Chlorine creates temporary molecules that damage plants. There are disagreements as to what level of free chlorine in the water is safe for irrigating plants. This point has been complicated by recent research, which proved that 2 ppm of free chlorine at the hose end is needed to kill pythium spores in water. Many horticulturists have stated in other research that 2 ppm of free chlorine is right on the edge of phytotoxicity.

The other widespread problem with chlorination is the design of the holding tanks. You want mixing and holding of the water for 30 minutes. You can't add water to the top of a tank while pulling it out the bottom. If you try this, the water will flow laterally down the side of the tank and out.

You need to add water to the bottom of the tank and pull it out the top. This requires a pump with a backflow check valve. Fancy stirring devices and baffles in the tanks aren't needed, but are helpful.

The dose of chlorine that must be added to the water is calculated by working backwards. The dirtier the water, the higher the chlorine demand will be. Also, high pH water takes more chlorine. Therefore, prefiltering and buffering the water initially helps a lot. Chlorine demand will usually change throughout the year. Automatic dosage devices help here.

You can use several types of chlorine. Granulated pool chlorine (sodium hypochlorite) is the most popular. Chlorine as a pressurized gas is dangerous. There are now many government regulations that kick in if you want to use gaseous chlorine. I don't recommend using chlorine gas!

There's a new method of using electrolyzed water that breaks down sodium chloride into sodium hydroxide and hypochlorite that's being researched. It might be a cheap way to utilize chlorine. But you need very clear water to make this work.

A potential problem with using chlorine is the formation of trichloromethanes, chloroamines, chlorophenols and chloroacetic acids in the water when residual free chlorine reacts with organic matter as it enters recycling ponds. These compounds are related to plant herbicides. If your original chlorinated water is recycled, there's a chance that the returning water may contain these molecules. Plants, especially geraniums, may not grow well.

Chlorine dioxide (ClO_2) is starting to be used now. Its use is popular in Europe, but not so common here. ClO_2 is widely used to wash fish, vegetables and fruit after harvest to prolong shelf life. Many municipalities and water parks now use ClO_2 to sanitize water.

The use of ClO_2 for greenhouse water sanitation will become more popular in the future. Cost is a consideration at this time. Prefiltering water greatly decreases the dose needed. Even if you can't pre-filter your water before treatment, ClO_2 will operate more efficiently in dirtier water because the compound is a much stronger oxidant than chlorine.

ClO_2 doesn't react with water (hydrolyze), as chlorine does. Killing time is very short, so you only need minimal holding times after treatment. Also, if there's no light present, the chlorine dioxide is more stable. Finally, it breaks down only to harmless sodium chloride in small amounts.

Ozone is widely added to water to sanitize it. This is also a holding tank method. However, the time required to hold water with ozone is shorter than with chlorine. Again, the method is popular in Europe. Many municipalities in this country now use ozone to sanitize the water. It's the strongest oxidizer we can use for water sanitation.

Ozone generators usually work at relatively slow flow rates. However, several can be set up in parallel fashion to allow for faster water treatment. Make sure the dose is adequate: You need 1.5 mg of ozone per liter of water, held for 20 minutes. You'll also notice how ozone in the water kills algae.

Peroxides added to water are coming into wider use in this country now. You can use peracetic acid products or industrial-grade hydrogen peroxide. Information on correct dosage is scanty. The products can injure plants. Many feel that 200 ppm peroxide is needed and safe on plants. You can use less peracetic acid, because it's more stable in water.

Peroxides aren't stable in air, so you must use care when calculating the dose and diluting the products. Always use fresh preparations. It's difficult to measure the actual amount of peroxide in a solution. Most growers assume, often incorrectly, that the peroxide concentration on the label is what they have. This is not so with old product!

Many growers consider adding copper ions to water to clean it. Whereas this may be a good idea for other reasons, I've seen no data on its efficacy in removing plant pathogens from the water. There's also some research going on with other copper products added to the water. The EPA now frowns upon copper algaecides because they consider them water pollutants.

There's some research on adding soaps or wetting agents to water to destroy zoospores of pythium and phytophthora. The work was done on hydroponic growing systems with vegetables. Unfortunately, any system other than hydroponic usually involves recycled water with more than just the zoospores of these pathogens.

One size doesn't fit all

In conclusion, there are many ways to go about water sanitation. *No one method fits all.* If you can't sanitize all the water you use, consider sanitizing the water used for propagation or for crops very susceptible to root rots. Also, you can use more than one sanitizing system in combinations, such as filtering and use of chlorine dioxide or ozonation.

Many plant pathologists around the country are skeptical of the advisability of recommending a water-retention and reuse system, especially ebb-and-flood systems. This puts them seriously out of step with the EPA, government water regulation people and many horticulturists.

There's no doubt that more stringent water conservation practices are rapidly approaching our industry. Usable fresh water is one of the rarest natural resources in the world and it's getting rarer each year.

—C. C. Powell is president of Plant Health Advisory Services, Columbus, Ohio.