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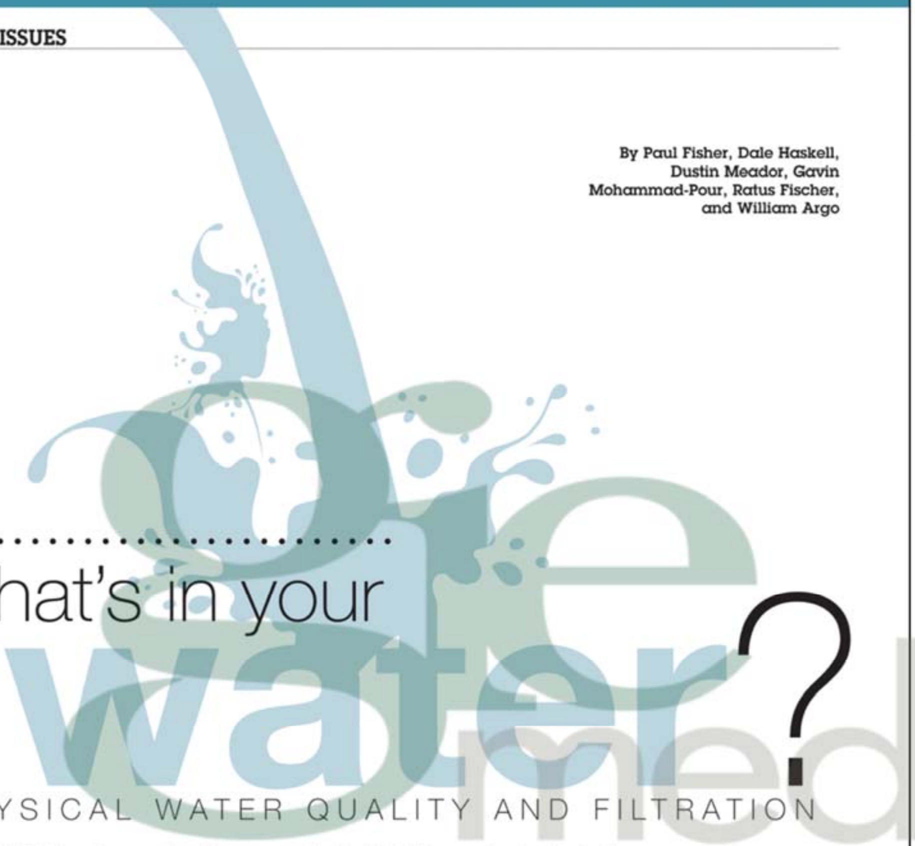

What's in your water?

PHYSICAL WATER QUALITY AND FILTRATION

Third in a four-part series on monitoring irrigation water for floriculture crops

Filtration can be a significant investment, especially when irrigating from a pond or using recirculated water. If filtration is working correctly, irrigation emitters should not be clogged from suspended particles, and total suspended solids should decrease after filtration. Filters should also remove peat and other particles that create a "demand" on sanitizing agents such as chlorine, copper and ozone.

Total Suspended Solids

Total Suspended Solids (TSS) is the concentration (in milligrams/liter or mg/L) of all particulate matter contained in a water sample, and includes fine particles of peat, silt, clay, microbes and other materials. To measure TSS, a water sample is filtered through a very fine screen, which is then dried and weighed.

Suspended solids indicate the clogging potential in micro-irrigation lines. Levels below 50 mg/L are generally considered to have low risk, 50 to 100 mg/L moderate risk, and >100 mg/L high clogging risk for drip irrigation systems. In a survey of 24 floriculture operations throughout the United States, including surface and recirculated water samples, University of Florida research found that suspended solids in all samples ranged from 0 to 39 mg/L, indicating a low clogging risk from TSS. However, values as high as 280 mg/L will occasionally occur with subirrigation water returning from dirty flood floors.

Tests of water samples taken before and after filtration can evaluate the effectiveness of a filter system. TSS before paper filtration in one greenhouse was 11.7 mg/L, and dropped to 5.9 mg/L after filtration. This indicated that 50 percent of TSS was removed and TSS was in the acceptable range for non-edible crops. In another greenhouse with high TSS in return water from a flood floor (above 100 mg/L), we found that filtration had no effect on TSS because the filter was overloaded and water probably bypassed the filter or moved through large pores. As TSS increases, multiple stages of filtration become necessary.

Total suspended solids can be measured on water samples taken before and after a filter to measure filtration efficiency.

Laboratory reports may distinguish between "organic" suspended solids such as peat and microbes, and "mineral" solids such as clay. You may be able to observe in a water sample whether solids are gritty and settle to the bottom (largely inorganic) or are soft, slimy and suspended or floating (largely organic). Sand filters are often used for water high in organic matter, while screen or centrifugal filters are often used to remove inorganic particles (see Table 1).

High suspended solids means that an increased concentration of a sanitizing agent such as chlorine (hypochlorous acid) must be injected so there is enough residual active ingredient to control waterborne pathogens. Suspended particles such as peat create a demand on the active ingredients. As the concentration of TSS increases, particles rapidly use up the active ingredient, and more chlorine must be injected to provide the desired residual concentration of free chlorine. Recommended thresholds for TSS to avoid excess demand are <20 mg/L for irrigation water used on non-edible crops and <5 mg/L for irrigation of edible crops.

The concept of demand is illustrated in a trial we ran at the University of Florida (Figure 2). Chlorine was applied at 2 ppm to a deionized water solution containing finely-screened peat, and the residual free chlorine was measured two minutes later. A residual concentration of 2 ppm free chlorine is recommended to control *Pythium* and *Phytophthora* zoospores. The data showed that 50 mg/L of suspended solids from peat created a demand of 0.5 ppm of free chlorine at two minutes of contact time. This means that 2.5 ppm of chlorine would need to be injected for 2 ppm of residual chlorine to remain. Other trials show that the longer the contact time between TSS and the sanitizing agent, the higher the demand.

Turbidity and ultraviolet transmission

Turbidity refers to the lack of clarity of water that results from fine suspended particles of clay, silt, organic and inorganic matter, and microbes, as well as other colored contaminants such as fertilizer dyes and micronutrient chelates. Highly turbid waters often will have high TSS that limits light penetration. For floriculture production, turbidity measurements can be used to ensure effective use of UV light for control of waterborne pathogens.

Table 1. Filtration options for greenhouses and nurseries (reprinted with permission from Ratus Fischer)

WHAT TO FILTER OUT		SCREEN/MESH FILTRATION		MEDIA FILTRATION			MEMBRANE FILTRATION			
		4 – 50 U.S. Mesh (5000 – 300 μm)	50+ U.S. Mesh (<300 μm)	RAPID SAND	SLOW SAND/ BIO-FILTER	PAPER/ FABRIC 5–50 μm	MICRO 1 – 0.1 μm	ULTRA 0.1 – 0.01 μm	NANO 0.01 - 0.001 μm	REVERSE OSMOSIS <0.001 μm
INORGANIC PARTICLE	Debris	++	++	++ Small load only	Not intended for large amounts of solids.	++	Particles other than intended for a specific membrane will shorten its life span, or destroy it. Proper pre-treatment of the water is essential.			
	Sand	+	++	++ Small load only		++				
	Silt	–	++	++ Small load only		++				
ORGANIC PARTICLE	Debris	++	++	++ Small load only	Excess solids will clog bio-active zone	++				
	Soil Particles	+	++ Small load only	++ Small load only		++				
	Algae, Biofilm	–	++ Small load only	++ Small load only		++	Will clog membranes			
	Pathogens	–	–	Minor effect	+ in small amounts	Minor effect	+ Except viruses	++	++	++
DISSOLVED INORGANICS	Salts , Iron	–	–	–	++	–	–	–	–	++
	$CaCO_3$ (Hard Water)	–	–	–	–	–	–	–	++	++
DISSOLVED ORGANICS	Humic acids	–	–	–	–	–	–	–	++	++
	Pesticides Herbicides	–	–	–	–	–	–	–	++	++
NOTES		Mainly pre-filtration. Drippers, nozzles need 120+ U.S. Mesh	Substantial dirt loads require back-flush systems	Back-flush standard. Not for heavy dirt loads.	Low flow only. Pre-filtration for heavy dirt loads	Handle heavy dirt loads in one step	Require lower pressure than reverse osmosis. Membranes are tailored to specific applications. Rejection rates (discharged portion of the feed water carrying concentrated waste) generally smaller than for reverse osmosis.			Removes almost everything. Typically back-blended with supply water.

Dimensions: 1 μm = 1micron = 1000 nm = 1/1000 mm = 0.00004 inches.
Legend for efficacy: ++ indicates good, + fair, and – not effective filtration.

Table 2. Key physical water quality measurements available from water testing laboratories

Measurements	Significance	Target range
Total Suspended Solids	Indicates need for additional filtration. High TSS clogs emitters and reduces efficacy of sanitizing agents.	<20mg/L for reuse on non-edible crops <5mg/L for edible crops
Turbidity and UV Transmission	Indicates efficacy of ultraviolet light for water sanitation.	<two nephelometric turbidity units (NTU) or >75% UV transmission
Particle size distribution	Indicates filter pore size required to remove suspended solids	

Values above 2 NTUs (Nephelometric Turbity Units) of turbidity, or less than 75 percent UV transmission, indicate that UV treatment is not likely to be effective. In our survey of 24 floriculture operations, we found the majority of recirculated water samples had less than 75 percent UV transmission, indicating pre-filtration would be required before UV treatment.

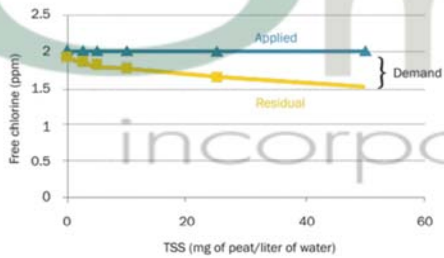

Figure 2. Effect of increasing total suspended solids (TSS) on free chlorine level after 2 minutes. The demand equals the difference between the applied and residual free chlorine levels.

Particle size distribution

Some laboratories can test the distribution of particle sizes (measured in µm, also called microns) in an irrigation water sample, which can help in selecting the appropriate filter size to reduce suspended solids. Figure 3 shows the distribution of particles in irrigation water (which included well, municipal

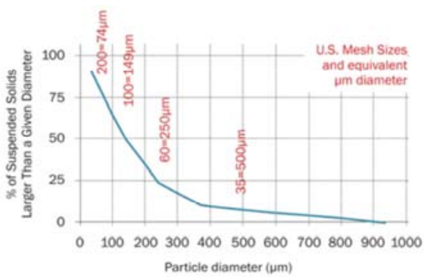

Figure 3. Particle size distribution in irrigation water. To use this graph, read up from a given particle diameter and read left to see the percent of suspended solids that would be filtered out if your filter had that micron diameter.

and recirculated samples) from a survey of 16 floriculture operations. The graph shows 50 percent of particles were larger than an average 138 µm, which is roughly equivalent to a 100-mesh screen. If a filter was 60, 100 or 200 mesh (250, 149 or 74 µm), based on Figure 3 these filters would be expected to reduce TSS by about 25, 50 or 75 percent, respectively.

Suspended particle sizes vary between water sources, and the median (50 percent) particle size ranged from 73 to 177 µm for the 16 locations we tested. That is why testing particle size for your water source is advised.

Other essential considerations for selecting filter pore size are the types of nozzles, orifice size, flow rate, volume and pressure for your irrigation system and components. Specifications for emitters are normally provided by the manufacturer. The filter should be fine enough to ensure particles are removed that would be too large to pass through the emitters. The finer the pore size, the greater the restriction on flow rate.

If you have problems with clogged emitters, a filter system that does not seem to be working or a sanitizing agent that does not seem to be controlling problem microbes, poor physical water quality may be to blame. Consider sending a water sample to a laboratory to test the parameters listed in Table 2. **GM**

Reference for TSS ranges: U.S. EPA, Municipal Support Division Office of Wastewater Management; Guidelines for Water Reuse

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