Managing Biofilms

Biofilms can create many problems in nurseries including reducing flow in irrigation pipes, blocking emitters, and producing slimy surfaces. While attempts can be made to eradicate biofilm by the treatment of pipes and surfaces, there are a number of features of biofilms that make it difficult to entirely remove these organisms from a system.

1. Biofilms concentrate nutrients. There are sufficient levels of nutrients in water for biofilm growth, even in water containing nutrients below measureable levels. In nurseries, particularly where water is being recycled, there may be significant amounts of nutrient in the water and, consequently, there are generally significant problems with biofilms in these situations. Even potable water that has been sterilised and has low nutrient levels can still support the growth of biofilms.
2. Biofilms attach to the very edge of the pipe where the force of water flowing past isn't sufficient to dislodge them.
3. Biofilms can attach to most surfaces, even very smooth stainless steel.
4. Biofilms have the ability to shield themselves with slime which reduces the effectiveness of biocides.

So how can biofilms be managed?

1. ***Reduce nutrients*.** The first step in managing biofilm is to reduce the amount of nutrients in the water available to biofilms. Water may be purified to remove nutrients but biofilms will concentrate the small amount of nutrients remaining. Bacteria may also be able to utilise the pipe glue and plasticizers from PVC pipes, the cellulose membranes in RO filters and trace elements from metal pipes as sources of nutrients. In nurseries, keeping the levels of nutrients in irrigation water as low as possible will reduce the growth of biofilms, but will never eliminate them. Practices such as using reed beds to reduce nutrient loads may be of some benefit in achieving this.
2. ***Flush pipes***. Flushing pipes will help to reduce the thickness of the biofilm. However, biofilms develop at the edge of pipes where the velocity of the water is zero, so a great deal of flow and turbulence is required for effective flushing and, at best, this will only remove the outer parts of the accumulated biofilm. While high water velocity doesn't prevent biofilms establishing, it will reduce the thickness and volume of biofilms and this needs to be considered when designing pipe sizes in irrigation systems.
3. ***Smooth surfaces***. The type of material the surface is made of has little or no affect on biofilm development, with stainless steel just as susceptible as plastic pipe. Rough surfaces have more surface area and, while smoother surfaces delay the initial buildup of attached bacteria, smoothness does not appear to prevent the development of biofilms. Smooth pipe should support less biofilm because it has less total surface area than rough pipe, and rough surfaces provide more protection from the flow of water that would remove biofilm. Smooth surfaces should also have less bio-corrosion due to the decrease in currents that flow between the peaks and valleys of a rough surface.
4. ***Sanitise surfaces***. Sanitisation will reduce the amount of biofilm that develops. The effectiveness of oxidizing biocides decreases in the following order - ozone>chlorine dioxide>chlorine>hydrogen peroxide. Typical chlorine levels in town water are between 0.5-2.0 ppm. This amount of chlorine has been shown to kill free-floating bacteria, but may not be enough to kill biofilm bacteria due to the protection afforded by the slime on the biofilm. Therefore, high doses over a short period are more effective at diffusing into the slime than low doses over a long period. If high doses are combined with flushing there will be a higher uptake of chlorine and a greater flushing effect. Decreasing pH will also enhance the effectiveness of chlorine treatment due to the production of more efficient forms of chlorine. Quaternary Ammonium compounds (QATs) are a non-oxidizing biocide option that may have some effects in specific situations e.g. preventing biofilms on nursery surfaces, and anionic and non-ionic surfactants can also be used, but their effect is limited. In some situations heat could also be considered if surfaces or pipework can be heated sufficiently e.g. pipework in bottom heat systems or steam cleaning surfaces.

Incomplete removal of biofilms means a rapid reintroduction will occur, so any treatment applied needs to be done thoroughly. Under perfect growing conditions, a bacterial cell divides into two daughter cells once every 20 minutes. This potentially means that, in 8 hours, 2 million cells could be produced from 1 parent cell. Fortunately, these rates are never realised because the bacteria are limited by space and available nutrients.

Effective management of biofilms requires a multipronged and consistent approach and the application of the above methods will help in achieving this.

Lex McMullin
Farm Management Systems Officer
Nursery & Garden Industry Queensland
Mobile: 0400 005 236
Email: fmso3@ngiq.asn.au