# RECYCLING IRRIGATION WATER

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Water is the largest single ingredient involved in plant growth, yet it has generally been taken for granted, used inefficiently, and discharged uncaringly. After all, it's only. . . water! But times are changing; the population is growing; environmental concerns are increasing; and the quantity of available, good quality water is decreasing.

Water recycling is a relatively new factor that can have major implications on plant growth. At a few nurseries this has been a voluntary action (5), at others it has been mandated. Governmental agencies have essentially taken the position that whatever a nursery does to the water they use, they must live with in the future, via collection and recycling.

Four major changes in water occur as a result of collection and recycling. Pathogen populations build up, water chemistry changes, herbicides and weed seeds accumulate.

**Pathogens.** The pathogens are mostly the water molds *Phytophthora, Pythium, Rhizoctonia,* and others. Because earth is an excellent filter, most wells are pathogen-free. However, once the water flows across plant surfaces, leaches through containers, and bathes dead leaves, clippings, and other debris on the container-bed surface, it is a different story. Decaying organic matter carried along with or suspended in the water creates a haven for water-mold pathogens (6). These are the so-called root rots.

The worst of the lot is *Phytophthora* (6). When water is collected and recycled, the population of disease organisms generally increases dramatically. This increases the diseases pressure on the plant. For example, if there are 500 spores of *Phytophthora* per gallon of irrigation water, all plants may grow well with few, if any, noticeable complications. Plant roots are generally white at the tips and back some distance, depending on the species. If the spore population increases to 5000, those plants growing in areas where drainage around the container is poor are likely to show reduced growth, and inspection of the roots shows white root tips only. If the spore population reaches 50,000, many of the plants will grow poorly or die because of the severity of root damage. The slower the plants grow, the greater the stress level that may predispose them to some weaker pathogen that is not normally a problem. A prolonged rainy period may be the thing that tips the environmental scale in favor of the pathogen, changing what looked like a fair crop into a disaster.

There are two practical treatments to reduce the pathogen load: chlorination and bromination. Water can be chlorinated by either granular calcium chloride on a small scale or gaseous chlorine on a larger scale. The key is having enough free chlorine (about 0.5 ppm) in the water for sufficient time (roughly one minute) to kill the pathogens. Various techniques have been used to increase exposure time such as double-loop intake lines or injection of the chlorine in the surface water where it enters the suction line. The pump's impeller further aids mixing.

Daughtry (3, 4) provides good information on the experiences of using gaseous chlorine at Lancaster Farms, Suffolk, Virginia. It is important to remember that chlorine gas is very hazardous and must be handled with adequate safeguards.

The newest technique for control of water-mold pathogens is the use of Agribrom. The concentration required is higher than for chlorine (5 to 10 ppm of free residual bromine vs. 0.5 ppm chlorine) but it is safer to handle and is reported to be equal to, or better than, chlorine in pathogen control in irrigation water. Exposure time is about the same as with chlorine (about one minute) (2).

**Water chemistry.** Recycled water will, in nearly every case, have a mineral composition different from the original water source. In a case where the container nursery operates with black poly over the soil surface, the mineral composition of the water may be lower in the collection reservoir. This is because the growth medium in the containers absorbs some of the minerals such as calcium, magnesium, sodium, potassium, and some of the micronutrients. Further, if any soil contacted by the water during its flow back to the reservoir is highly leached and acidic, some additional bases may be removed. On the other hand, if the container beds are lime rock or some other material containing a soluble element, that element is likely to be found in the reservoir.

It has been my experience that surface-water sources tend to have a much lower mineral composition than well water. Water in wells percolates through the soil, ultimately accumulating in a sand or rock strata beneath the surface. In many areas, the key material through which the water must percolate is limestone. Even though the solubility of limestone is quite low, it does dissolve sufficiently to change the chemistry of the water. In areas where the rainfall is acid or increases in acidity after moving through highly acid soils, the limestone below is dissolved more rapidly, thus hastening the rise in dissolved minerals. This change does not occur in water that accumulates after running across the surface of the soil.

Two cases are worth noting here. In one case, the nursery takes its water from a stream that originates in a soil area of nearly pure sand that is very acid. The pH of the water is about 5, but there are few minerals in the water. When this water percolates through containers, it very quickly dissolves the dolomite used as a calcium and magnesium source. The result is severe magnesium deficiency, mild calcium deficiency, and very unattractive plants. The solution is to switch to a much less soluble source of magnesium, magnesium oxide, (7, 8, 9) and to coarse granules of calcium carbonate to reduce particle surface area. Increasing the size of the particle of a material with moderate water solubility extends the time required for it to be dissolved.

In the other case, a nursery has a good supply of irrigation water, but the water is high in bicarbonates. Sulfuric acid is injected to reduce the bicarbonates to a level that will not cause foliar damage. The pH of the water is lowered from about 7.8 to 6.2. This is a desirable practice, and the lower pH of the water creates no complication or injury to the crop directly. However, the nursery was designed with limestone-covered beds and roadways. When the acid water runs over and percolates through the lime rock, the calcium level in the water rises from the base level of about 70 ppm to over 200 ppm.

In this case the calcium increased dramatically, but the magnesium increased very little due to the composition of the limestone. The problem was two-fold. The level of magnesium must be increased to narrow the Ca:Mg ratio to about 2:1, and the level of micronutrients in the growth medium must be increased to minimize the negative effects of the high calcium. Since there is no practical treatment for the removal of calcium dissolved in water, the effective approach is to minimize its negative effects. In most cases water from the original water source can be blended with the recycled water to provide a mineral composition suitable for plant growth (5). However, in nearly every case, some adjustments in the additives to the base mix are required because of changes in water chemistry.

A few other suggestions. DO NOT inject any micronutrients into irrigation water. Minimize the use of liquid fertilizers to reduce algae and weed problems. Good slow-release systems are available that contribute very few nutrients to the runoff water and in turn, make recycling less complicated.

**Herbicides.** Recycled water will reflect the practices used in the nursery. If a water-soluble herbicide is used anywhere in the system, it will be in the accumulated water. Do not treat the soil/gravel surface beneath containers with Princep (simazine). With a water solubility of 3.5 ppm and at the rates used for soil sterilization, Princep will be in the recycled water returned to the crop. It will accumulate in containers over time and will damage most species other than conifers.

While visiting a container nursery several years ago, I was asked if I would look at some problems they were having with yaupon holly. After looking at tops and roots of several holly, I asked to see their barberry. I was told they had all died. Then I asked to see althea, rose-of-sharon. Same reply! Then how about crapemyrtle? Same reply! I then asked if the gravel-covered container beds had ever been treated with simazine. Yes, just last spring because another nursery was doing it and said it worked well. The difference was that the other nursery did not recycle their water.

My advice is never use an herbicide with a water solubility greater than 1 ppm in a container nursery. The preemergent herbicides (and their water solubility in ppm) that fall in the *desirable* category are Goal, 0.1; Ronstar, 0.7; Treflan, 0.3; and Prowl (pendimethalin), 0.5; and probably Galaxy, 1.0 (1).

The undesirables are Surflan, 2.5; simazine, 3.5; Devrinol, 75; Lasso, 242; Pennant or Dual, 530; and Karmex, 42. Every recycle catch pond should have a silt collector. This can be a shallow pond above, a grass vegetation area to slow the water, or some other technique. Even with very low water solubility herbicides, some can accumulate in the recycle pond. However, the desirable products will be attached to soil and organic particles and will be dissolved in the water only in extremely low levels. Thus, if the silt and organic matter are allowed to settle out before reaching the main reservoir, the problem can be minimized.

**Weeds.** Seeds of some weed species are very small. It has been my experience that nurseries that recycle their water have a much greater problem with prostrate spurge than those that do not. The seed is very small and will pass through most screens and orifices.

I have irrigated from a surface water supply for many years, and the clues began to mount. In years when the reservoir was low, and by July the exposed soil around the water line was covered with prostrate spurge, our problems in the containers were much greater. In the next year the reservoir was high all season; our problems with spurge were minimal. It took a layer of a very finely woven fabric suspended in an empty 10-gal. container and several waterings to find the seed. Interestingly these seeds were very viable. In later studies with spurge seed collected in the fall, the seeds would not germinate. It is as if they have a built-in sensor and know not to germinate unless in a container!

The practical solution appears to be a fine sand filter, in combination with the vegetation trap and one or more silt ponds above the major collection reservoir.

**Sanitation.** Since the water that returns to the recycle reservoir has bathed nearly everything in the nursery, it can be either a real cesspool or a pristine pool, depending on the management of the nursery. My advice is to rogue out diseased or problem plants consistently, control water mold pathogens with chlorine or bromine, monitor and adjust nutrients in the mix as indicated by the chemistry of the water, control weeds everywhere including roadways, ditches, and banks of the reservoirs, and monitor plant growth and health closely. Concentrate on preventing problems rather than treating for, or trying to cure, problems later. Water frequently, but lightly, so as to minimize runoff. My recent studies suggest that this not only minimizes runoff but enhances plant growth and quality as well.

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