Improving Water and Fertilizer Efficiency in Greenhouses

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Prevention of fertilizer run-off and efficient use of water are becoming increasingly important issues in Georgia's floricultural industry. Fertilizer run-off can cause contamination of surface and ground water, and legislation to prevent pollution is becoming stricter. In addition to the problem of possible pollution, fertilizer run-off is an economic loss for growers. In extreme cases, as much as 85 percent of all applied fertilizer can be lost from a greenhouse.

Water loss from greenhouses is likely to become a more important issue over the next few years, especially in the metro Atlanta area. As Atlanta keeps growing, its water demand will increase accordingly. Competition for clean and cheap water inevitably will increase during the next decade.

If we address these issues now, we may prevent them from becoming serious threats to the future of floriculture in Georgia. A good faith effort now may also help later if the state legislature considers stricter environmental legislation.

Growers can decrease run-off and water use in their greenhouses in many ways without sacrificing the quality of the plants. Some of these options are expensive and require a major investment from the growers. Other possibilities require only small changes in growing practices, don't cost anything and will actually help save money.

Efficient Watering

An obvious way to reduce water use in the greenhouse is to make sure more water stays in the pots and is available to the plants. If you grow potted plants in 6-inch round pots, and you place the pots 4 inches apart, only 28 percent of the bench or ground will actually be covered by the pots. If these pots are watered by hand or sprinklers, most of the water (and fertilizer, if you use water-soluble fertilizer) will likely end up on the floor instead of in the pots. The fraction of water lost can be decreased considerably if the plants are watered carefully, but losses will always be significant. Spaghetti tubing generally is a better option for potted plants, while recirculating watering systems can be used, too. The initial investment in spaghetti tubing will normally be earned back quickly — watering can be automated, resulting in significant labor savings.

Pulse Irrigation

Water will also be used more efficiently if leaching is kept to a minimum. Most crops can be grown without any leaching unless excess fertilizer is used. Less leaching and not using excess fertilizer will obviously result in less water use and decreased fertilizer run-off. However, it can be difficult to wet all the medium in a pot without notable leaching.

When spaghetti tubing is used, sometimes one part of the pot will be saturated before the rest of the medium has absorbed much water, resulting in leaching before the plants have been watered adequately. If this is a problem, it can be solved by using cyclic or pulse irrigation.

With pulse irrigation, the pots are watered several times for short periods. Because the pots are watered only for short periods at a time, the water will have ample time to be redistributed in the pot between waterings. Irrigating five times for one minute will result in less leaching and run-off than irrigating once for five minutes. A potential problem with pulse irrigation is that, on long benches, drip tubes at one end of the bench may start dripping up to 10 seconds before tubes at the other end of the bench will emit any water. This may not be a problem when plants are watered only once or twice a day, but with pulse irrigation this can result in important differences in watering from one end of the bench to the other. For pulse irrigation, the drip system should be designed so all drip lines start emitting water at approximately the same time.

Drip Emitters

An alternative to pulse irrigation is the use of drip emitters. These emitters can be attached to the end of the spaghetti tubing; they will discharge a relatively slow, constant flow of water. The flow rate is largely dependent on water pressure and normally results in a very equal water distribution across an entire bench. Because the water flow is much slower than with regular spaghetti tubing, the water distribution throughout the pot is better and less water is needed. It is possible to use pulse irrigation with drip emitters, but, in most

cases, just using one of these options can greatly improve water and fertilizer efficiency.

Timed Leaching

In some cases, it may be necessary to leach the growing medium. Fertilizer run-off can then be reduced by using timed leaching. The main nutrients that can cause run-off problems in greenhouses and nurseries are nitrogen and phosphorus. Fortunately, plants are efficient at taking up nitrogen, phosphorus and some other nutrients . If leaching is postponed until after the plants have had a chance to take up the nitrogen and phosphorus in the bulk solution in the growing medium, less nitrogen and phosphorus will be leached out, reducing the threat of water eutrophication. Leaching should not be done at the same time that water-soluble fertilizer is applied. Wait as long as possible after fertigating before the pots are leached.

Capillary Mats

Capillary mats can be used to optimize water and fertilizer use. Normally, they are used with trickle irrigation, which applies water and fertilizer to the porous mats. The water and nutrients can then be absorbed by the growing medium and are available to the plants.

Fertigation amounts have to be closely monitored, because excessive watering can result in significant leaching from the mats, causing run-off. If the main objective is to reduce run-off, simply covering benches with capillary mats can be an improvement. Plants can still be watered by hand, sprinklers or drip irrigation, but the leachate will now be absorbed by the mats. As soon as the growing medium starts drying out, the leached water and nutrients will be available for absorption by the growing mix. This can result in more even water supply to the plants and more efficient use of fertilizer.

A possible problem with capillary mats is that roots may grow out of the pots and into the mat's surface if the surface stays moist continuously. This can probably be suppressed by treating the black plastic cover with a copper spray. (Capillary mats are available with and without a cover, but excessive algae growth often occurs when the mats themselves are exposed to light.)

Run-Off Ponds

A widely used method to reduce the possibility of nutrient contamination of ground and surface water is to collect the leachate from the greenhouse in run-off ponds. Fertilizer in the run-off water can be used by water plants grown in the pond. Some plants, such as cattails, are very efficient at using these nutrients and are known as *biofilters.*

Although collection ponds do not increase the efficiency of water and fertilizer use, they greatly reduce the risk of run-off problems.

Recycling Watering Systems

The most advanced way to prevent nutrient run-off and optimize water and fertilizer use is implementation of recycling watering systems. These systems were specifically designed to prevent run-off problems and are extremely efficient. Two recycling watering systems widely used in the United States and around the world are *ebb-and-flow* and *nutrient film technique (NFT).* The principle behind these two systems is similar.

In ebb-and-flow, the plants are grown on a watertight bench, which is flooded with nutrient solution as needed. After the pots have absorbed enough fertilizer solution, the solution is drained back into the solution holding tank and can be re-used later.

A more recent development in ebb-and-flow is *flooded floor watering.* Plants are grown on a concrete floor and the entire greenhouse floor is flooded with nutrient solution periodically. Both ebb-and-flow and flooded floor watering require that plants are grown on a level surface to assure even watering. Kits are available to convert regular greenhouse benches into ebb-and-flow tables.

NFT is similar to ebb-and-flow but does not require level benches. In NFT,plants are grown in sloped troughs. Nutrient solution is added to the high end of the troughs and flows down freely. The nutrient solution is collected at the lower end of the troughs and can be re-used. The water can be pumped around the NFT system continuously or intermittently, depending on the water requirements of the plants.

One drawback of using troughs is that they cannot be used with different pot sizes. If pots are too small for the troughs, the nutrient solution will channel past the pots without watering the plants adequately. You will need a separate set of troughs for crops grown in pots of different sizes.

This article gives a brief overview of some of the opportunities available to growers to optimize their water/fertilizer use efficiency. Not all options will be appropriate for every greenhouse operation, but perhaps some of these ideas will be of interest to you. Many of you already take measures to prevent run-off from your greenhouses. If you have any suggestions you think would be of interest to your colleagues, I would like to hear about them. I hope I'll be able to address these in a future issue of *Georgia Floriculture.* Send mail to my attention at the Department of Horticulture, Georgia Station, 1109 Experiment Street, Griffin, GA 30223. I look forward to hearing from you.