

MAINTAINING DRIP IRRIGATION SYSTEMS

BY
GARY A. CLARK
WILLIAM J. LAMONT JR.
CHARLES W. MARR
DANNY ROGERS



Drip irrigation systems are becoming more widely used for horticultural crop production, especially vegetable crops. The system must function efficiently during the entire growing season. Failure at a critical point in the crop production cycle can cause loss of the entire crop. System failures often are due to inadequate maintenance of the system, especially if fertigation is being utilized to supply nutrients to the plant's root zone. Maintenance of the drip irrigation system does take time and understanding; however, maintenance is critical for its successful use. This guide should help you understand how to maintain drip irrigation systems.

WATER QUALITY

Water for drip irrigation can come from wells, ponds, rivers, lakes, municipal water systems, or plastic-lined pits. Water from these various sources will have large differences in quality. Well water and municipal water is generally clean and may require only a screen or disk filter to remove particles. However, no matter how clean the water looks, a water analysis/quality test prior to considering installation of a drip irrigation system should be completed to determine if precipitates or other contaminants are in the water. This water quality analysis should identify inorganic solids such as sand and silt; organic solids such as algae, bacteria, and slime; dissolved solids such as iron, sulphur, sodium chlorides, and calcium; and pH of the water. Water testing can be done by a number of laboratories in the state. Your local Cooperative

Extension Service (CES) county agent can supply a list of laboratories or suggest a local lab that can do water quality analysis. Check with the lab first to obtain a sample kit containing a sampling bottle that is clean and uncontaminated.

In addition to quality factors, ask for any additional tests that might be necessary. If the water also is to be used as a household supply or as a drinking water source, a basic drinking water analysis, which includes bacterial counts, nitrates, or other suggested tests, should be done.

Most well water in Kansas has relatively high pH and hardness. Shallow wells in river valleys often contain high concentrations of iron and manganese. Hydrogen sulfide often can be detected by a bad "rotten egg" smell and is fairly rare in Kansas. If a review of your water test indicates factors that may cause plugging (Table 1), then special care in drip system maintenance needs to be practiced. High levels of a factor might not render a well unsuitable for drip irrigation but will make appropriate water treatment a requirement before successful use in a drip irrigation system.

Any surface water such as streams, ponds, lakes, rivers, or pits will contain bacteria, algae, or other aquatic life. Sand media filters are absolute necessities. Even though sand media filters will be more expensive than screen or grooved-disk filters, they are highly recommended for water sources that have high levels of suspended organic and inorganic materials.

Table 1. Criteria for Plugging Potential of Drip Irrigation System Water Sources

Factor	Plugging Hazard		
	Slight	Moderate	Severe
	[in parts per million (ppm)* except pH]		
Physical			
Suspended Solids (filterable)	<50	50–100	>100
Chemical			
pH	<7.0	7.0–7.5	>7.5
Manganese	<0.1	0.1–1.5	>1.5
Iron	<0.1	0.1–1.5	>1.5
Hardness	<150	150–300	>300
Hydrogen sulfide	<0.5	0.5–2.0	>2.0

*Some water reports list results as milligrams per liter, mg/L, which is equal to parts per million, ppm

MAINTENANCE OF THE SYSTEM FILTERS

Both screen and sand media filters in a drip irrigation system should be checked during or after each operating period and cleaned if necessary. A clogged screen or grooved-disk filter can be cleaned with a stiff bristle brush or by soaking in water. A sand media filter should be backflushed when pressure gauges located at the inlet and outlet sides indicate a 5 psi difference. Check drip irrigation lines for excessive leaking and look for large wet patches in the planting area that indicate a leaking tube or defective emitter. It is also a good practice to flush submains and laterals periodically to remove sediments that could clog emitters. Systems can be designed with automatic backflushing devices and automatic end-line flushing devices, but they still require manual checks.

CHEMICAL CONTROL MEASURES

Unfortunately, filtration alone is not always adequate to solve all water quality problems. Chemicals are necessary to control algae, iron, and sulfur bacteria and disease organisms. Chemicals can cause some materials to settle out or precipitate out of the water, while causing other materials to maintain solubility or stay dissolved in the water. Chlorine is a primary chemical used to kill microbial activity; to decompose organic materials; and to oxidize soluble minerals, which causes them to precipitate out of solution. Acid treatments are used to lower the water pH and either maintain solubility or dissolve manganese, iron, and calcium

precipitates that clog emitters or orifices. Potassium permanganate also is used to oxidize iron under some conditions. Place the filtration system after the chemical treatment to remove any particles formed. If the irrigation system is connected directly to the water source, chemical injection requires a chemigation permit from the State of Kansas. Requirements for chemigation protection and injection equipment vary with toxicity class of the injected chemicals.

BACTERIAL SLIMES/PRECIPITATES

Bacteria can grow in the absence of light within the system or in a contaminated well. The bacteria can live on iron or sulfur and produce a mass of slime that quickly clogs emitters and filters. This slime also can act as an adhesive to bind other solids together to cause clogging. They also can cause soluble iron and sulfur to precipitate out of the water.

Bacteria cause iron precipitation by oxidizing soluble ferrous oxide to form insoluble ferric oxide. Iron concentrations as low as 0.1 ppm can be troublesome, whereas levels of 0.4 ppm can be severe. The iron precipitate forms as a red filamentous sludge, which can attach to PVC and polyethylene tubing and completely block emitters.

Sulfur in amounts over 0.1 ppm of total sulfides can be troublesome in irrigation water. Bacteria that live on sulfur can produce white stringy masses of slime, which can completely block the emitting devices. Interactions of soluble iron and sulfur can lead to a chemical reaction that forms insoluble iron

sulfide. Stainless steel filter screens used in high sulfide water can cause iron sulfide precipitation.

Chlorination is the usual treatment to kill bacteria or inhibit their activity. A continuous residual rate of 1 to 2 ppm of free available chlorine at the distant end of the irrigation system or an intermittent rate of 10 to 20 ppm for 30 to 60 minutes per treatment cycle should be effective. The initial injection rate may need to be higher to achieve the desired residual level in the system. Treatment may be required at the end of each irrigation cycle for problem water sources or after every 10 to 20 hours of irrigation for cleaner water sources.

Wells sometimes are contaminated with bacteria, and shock chlorination is necessary to reduce or solve the problem. This is done by injecting chlorine at a rate of 200 to 500 ppm into the well. The volume of water to be treated must be estimated from the diameter and depth of the well. Consult a local well driller for exact procedures and regulations prior to attempting this activity. (See CES Bulletin MF-911, Shock Chlorination for Disinfecting Water Systems.)

ALGAE AND AQUATIC PLANTS

Algae and aquatic plants in surface waters can be great nuisances because they reproduce rapidly during summertime blooms. They have a tendency to become entangled in screen meshes and clog the surface of sand media filters, resulting in the need for filter backflushing. Algae can be controlled in surface waters by adding copper sulphate or other chemicals in an approved manner. Care must be taken to avoid harming fish. Green algae can grow only in the presence of light, so they do not cause a problem in buried pipelines or black polyethylene. However, algae can grow in the white PVC pipe or fittings used to assemble aboveground pipelines and then be washed into laterals and emitters to cause clogging.

Chlorine is used to kill algae within the irrigation system. A chlorine concentration of 10 to 20 ppm for between 30 and 60 minutes is suggested. To prevent emitter clogging, it is advisable to work section-by-section through the pipeline and flush the dead algae out of the pipes immediately after treatment. If significant emitter clogging occurs, a higher concentration may be needed to decompose the organic matter in the emitter.

CHEMICAL PRECIPITATION OF IRON

Water with over 0.1 ppm of iron is quite likely to cause a problem in irrigation systems. The problem can be solved by either removing the iron from the water or by retaining the iron in solution. Several techniques are available:

Aeration and Settling. A reliable way of removing iron from irrigation water is to pump the water from the well and to spray it in the air over a pond or tank. During aeration of the water, iron is oxidized into its insoluble form, which can settle out in the pond. The disadvantage is that the water must be double-pumped, requiring a second pump after the settling basin to repressurize the water. Energy costs are not increased, but two pumps must be purchased.

Chlorine Precipitation. Free chlorine will instantly oxidize ferrous iron to ferric iron and take it out of solution as a solid. The iron concentration must be determined, and chlorine must be injected at a rate of 1 ppm for each 0.7 ppm of iron. Some additional chlorine may be needed for other contaminants, such as iron bacteria and bacterial slime. Complete mixing of the chlorine and water is necessary and can be accomplished by creating turbulence in the system before the filter. A sand media filter is the most appropriate choice and should be backwashed frequently, preferably automatically.

If manganese is present in the water source, caution must be exercised, because oxidation of manganese by chlorine occurs at a much lower rate. Care must be taken to precipitate the manganese before the filter, or clogging problems could occur.

pH Control. Iron is more soluble at lower pH values. Acid can be injected continuously to keep the pH low in the irrigation system or can be used periodically to dissolve iron deposits. To dissolve the iron, the pH must be reduced to approximately 2.0 or less for a period of 30 to 60 minutes. The system must be flushed to remove the iron after treatment.

Iron precipitation can be caused by raising the pH. A solution to increase the pH can be prepared by mixing 3 pounds of soda ash (58 percent light grade) with 4 gallons of water. This neutralizing solution can be injected into the water system and can be mixed with chlorine solutions.

Iron Sulfide Precipitation. Sulfur-bearing minerals are common in most sedimentary rocks. A soluble form of sulfate is carried by water. Sulfates are difficult to precipitate and generally remain in solution. Sulfate can be used as a food source by bacteria that produce hydrogen sulfide gas as a by-product. If sufficient iron is present under moderate reducing conditions, iron sulfides can be precipitated, and a sand media filter is suggested to remove the precipitate.

IRON REMOVAL BY POTASSIUM PERMANGANATE

Iron also can be removed from water by an oxidizing filter charged with manganese-processed sand. The filter retains oxygen when regenerated with potassium permanganate. As water flows through the oxygen-charged fiber bed, iron unites with the oxygen and is changed to rust or iron oxide. The sand retains the iron oxide until the filter is backwashed and recharged with potassium permanganate. The filter will operate for water with a pH value between 7 and 8. The iron should not exceed 20 ppm.

Water containing more than 20 ppm iron or water with organic complexed iron can be treated best by chlorination and filtration. Super chlorination plus pH adjustment may be necessary. Complexed iron causes a condition where humic acids or other organic matter make oxidation difficult.

PRECIPITATION OF CALCIUM SALTS

Calcium salts, particularly calcium carbonates, precipitate out as a white film or plating in the system. The salts are soluble at low pH. Acid can be used to maintain a pH of 4.0 or lower for 30 to 60 minutes, which dissolves calcium deposits and cleans emitters and pipelines. Hydrochloric (muriatic) acid is recommended for treating calcium blockages, although sulfuric and phosphoric acid also can be used. Temperature, pH, and calcium concentration all influence calcium solubility, so conditions can vary throughout the irrigation system. Water sources differ in the amount of hardness and/or pH, so require different amounts

of acid to lower the pH. The most common acid that growers will find available at hardware and farm supply stores is muriatic acid (20 percent hydrochloric acid). Tests of several well and tap waters indicated that ½ to 1 gallon of this strength muriatic acid in 100 gallons of water is required to lower the pH to approximately 3.5. Be sure that you flush and clean the injector after acid application—the acid may be corrosive to internal parts. Allow the acid-treated water to remain in lines for 30 minutes to 1 hour, then flush with water. **Use extreme care in handling acids and always add acid to water.**

If the water hardness is excessive, water softening equipment can be used to remove calcium and magnesium. Zeolite water conditioners soften hard water by removing dissolved calcium and magnesium by ion exchange in a tank, where they are placed in a deep bed. As hard water flows downward through the bed, the calcium and magnesium ions are withheld by the mineral and replaced by sodium ions. When the sodium ions are exhausted, the system must be regenerated by a flow of salt water through the exchange material. A backwash procedure is used to remove the calcium and magnesium ions. If the water contains iron, an iron-removal filter should precede the water softener.

CHLORINATION

The common practice of chlorination is the addition of chlorine to purify drinking water supplies. Chlorine acts as a powerful oxidizing agent in water and vigorously attacks organic materials. Free available chlorine also reacts strongly with readily oxidizable substances such as iron, manganese, and hydrogen sulfide.

To be effective, active chlorine should leave a residual measurable in PPM of available chlorine near the end of the lateral lines of the irrigation system. The amount of chlorine added to the system will be the residual desired plus the amount needed by the water to oxidize the materials present. This amount can vary considerably over a season. Contact time between chlorine and the water should be maximized to get the most benefit.

Table 2. Common Chlorine Compounds Used in Microirrigation

Compound	Form	Percent Available
calcium hypochlorite	dry	65 – 70
sodium hypochlorite	liquid	5.26 – 15
chlorine gas	gas	100

CHLORINE FORMULA

A general formula for calculating the amount of chlorine to inject in liquid form (sodium hypochlorite, NaOC) is:

$$IR = Q \times C \times 0.006/S$$

where:	IR	=	Chlorine injection rate (gal/hour)
	Q	=	Irrigation system flow rate (gal/min)
	C	=	Desired chlorine concentration (ppm)
	S	=	Strength of NaOC solution used (percent)

Example: A grower wishes to use household bleach (NaOC at 5.25% active chlorine) to achieve a 3 ppm chlorine level at the injection point. The flow rate of his irrigation system is 90 gpm. At what rate should he inject the NaOC?

$$\begin{aligned} IR &= 90 \text{ gpm} \times 3 \text{ ppm} \times 0.006/5.25 \\ &= 0.31 \text{ gallon per hour} \end{aligned}$$

At an irrigation flow rate of 90 gpm, the grower is pumping (90 × 60) 5400 gph. The goal is to inject 0.31 gallon of bleach into 5400 gallons of water each hour that injection occurs.

If the injector is set for a 300:1 ratio, it will inject 5400/300 or 18 gallons per hour. Then, 0.31 gallon of bleach should be added to 18 gallons of water in the stock solution.

Note: be careful to use the same time units (hours) when calculating the injection rate.

The gas and liquid forms of chlorine are more commonly used (Table 2). Common household bleach, 5.25 percent sodium hypochlorite, is used in many small operations. Chlorine gas is more dangerous (very poisonous and very corrosive). A commercial dealer should install the gas metering device and a chlorinator and train the operators. Chlorine gas is heavier than air, so adequate ventilation is recommended.

The pH of the water greatly affects the effectiveness of chlorination. Acidic water causes greater availability of hypochlorous acid (HOCl), which has an efficiency for killing microorganisms that is 40 to 80 times greater than that of hypochlorite (OCl⁻). When chlorine is dissolved in water, HOCl and OCl⁻, which together are referred to as “free available chlorine,” coexist in an equilibrium relationship influenced by temperature and pH.

COMMERCIAL TREATMENT SOLUTIONS FOR MAINTENANCE

Several commercial solutions are available that contain a mixture of ingredients to deal with pH, iron, and other water problems. These commercial products come with instructions on dilution con-

centrations for daily maintenance or “shock” treatment to unclog plugged lines. For small producers getting started with drip irrigation, these products should be considered as water treatments.

SUMMARY

Drip irrigation is an extremely efficient method of controlling processes, such as availability and uptake of water and minerals. The correct use of a drip irrigation system requires different approaches or methodology than those used in conventional irrigation systems. This involves thinking in terms of frequent irrigation intervals, correct emitter selection and spacing for soil type and topography, control of irrigation depth, and more exacting maintenance of the system. It is important to consult an irrigation specialist in designing a drip irrigation system, so that the system will indeed perform as expected.

Correct use of a drip irrigation system can save water, reduce potential for groundwater pollution, improve water use efficiency, reduce disease pressure, and provide a mechanism for prescription nutrient applications.

Troubleshooting Guide for Drip Irrigation Systems

Symptom	Possible Causes	Refer to Section
A reddish brown filamentous slime or particles near emitters	Bacteria feeding on iron	Bacterial Slimes & Chemical Precipitation of Iron
White stringy masses of slime near emitters	Bacteria feeding on sulfur	Bacterial Slimes
Green or slimy masses in surface water sources	Algae or fungi	Algae and Aquatic Plants
White film or 'plating' on tape or around emitters	Calcium salts or calcium carbonates	Precipitation of Calcium Salts
Presence of silt or clay	Inadequate filtration	Maintenance of the System Filters

Note: A light treatment can be used for routine problems, whereas a stronger treatment may be required for plugging or more severe problems.

Kansas State University Agricultural Experiment Station and Cooperative Extension Service

MF-2178

April 1996

It is the policy of Kansas State University Agricultural Experiment Station and Cooperative Extension Service that all persons shall have equal opportunity and access to its educational programs, services, activities, and materials without regard to race, color, religion, national origin, sex, age or disability. Kansas State University is an equal opportunity organization. Issued in furtherance of Cooperative Extension Work, Acts of May 8 and June 30, 1914, as amended. Kansas State University, County Extension Councils, Extension Districts, and United States Department of Agriculture Cooperating, Marc A. Johnson, Director.