Colorado State University
Extension

Micro-Sprinkler Irrigation for Orchards

Fact Sheet No. **4.703**

Crop Series | **Irrigation**

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Micro-sprinkler irrigation has become established and widely used in Colorado orchards in recent years because of its potential to increase yields but more importantly because of the increased irrigation efficiency and decreased labor requirements. However, there is an increase in the amount of time required to manage the system properly to realize the gains in efficiency compared to gated pipe/furrow irrigation. Micro-sprinkler irrigation applies water directly to the soil surface area allowing water to dissipate under low pressure and infiltrate orchard soils in a wetted profile that uniformly meets water demand throughout the orchard block. Compared to gated pipe/furrow irrigation, water use on orchards with micro-sprinklers is typically 30% less, and can be as much as 50% less with close attention being paid to irrigation system management. All else being equal, this increased irrigation efficiency can mean the difference between small or medium sized fruit and crop, and a good or full sized fruit and crop in 'water-short' years.

Some of the additional advantages of micro-sprinkler irrigation systems are: the potential for reducing frost damage, greater control over water application times and amounts to more closely match local evapotranspiration (ET) rates to maintain optimum soil moisture. The lower susceptibility to clogging due to larger orifice sizes than drip irrigation systems also reduces the need for extra fine filtration. Orchard micro-sprinkler irrigation systems operate under low pressure, typically 20 to 35 psi, with wetting patterns of 10 to 30 feet, and a variety of discharge flows of 8 to 90 gph, to more closely match soil infiltration rates, orchard size, tree maturity and spacing and the depth of the rooting system. Timing irrigations to only irrigate to the maximum depth of the tree root zone can also increase fertilizer efficiency by significantly reducing or eliminating leaching of nutrients below the tree root zone.

System Layout and Equipment

Micro-irrigation systems consist of a system 'head' and a distribution network. A pump, filter, flow meter (optional), pressure gauges, fertilizer injector (optional), pressure regulator, and controller (optional for manual systems) generally make up a system head (Figure 1). The meter and acid injector are optional equipment but highly desirable because they help monitor system performance (flow meter) and add flexibility to the system (injector). The distribution network consists of pipes usually made of polyethylene (PE), pipe fittings, sprinklers and valves. Valves can be actuated electrically by a controller connected to a solenoid valve in the case of an automated system or manually.

When sediment is found in irrigation water, typically ditch systems; water filtration is essential for protecting sprinkler nozzles from clogging and the irrigation system from rapid wear. Two basic types of filters are sand media filters and screen/spin filters. At least one stage of filtration is needed for micro-irrigation systems, though micro irrigation sprinkler systems usually require less filtration than drip irrigation systems, filtration is a must if not using well water. The bigger the orifice of the sprinkler, the less filtration is needed. In western Colorado's fruit growing areas, early season irrigation (ditch) water is usually sediment laden and controllers with automatic filter back flushing cycles are a must to reduce labor costs as non-self flushing systems typically have to be manually cleaned hourly or more often early in the season. The required screen size or sand filter size is determined by the sprinkler type, orifice size, and amount of contaminants in the water source.

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Quick Facts

- Micro-sprinkler irrigation is a low pressure, low to medium volume irrigation system suitable for high value crops such as tree fruits.
- If managed properly, micro irrigation can increase yields and decrease water use and fertilizer and labor requirements when compared to gated pipe/furrow irrigation systems.
- Micro-sprinkler irrigation saves water because of the high application efficiency and high water distribution uniformity with little if any waste if managed properly.
- Micro-sprinkler irrigation is ideal for irrigating sloping or irregularly shaped orchard blocks that cannot be flood/furrow irrigated.
- An additional increase in efficiency can be obtained by the addition of fertilizer injection to the system. Water-soluble fertilizers can be injected through a micro-irrigation system thereby significantly reducing cost compared to traditional fertilizer applications.

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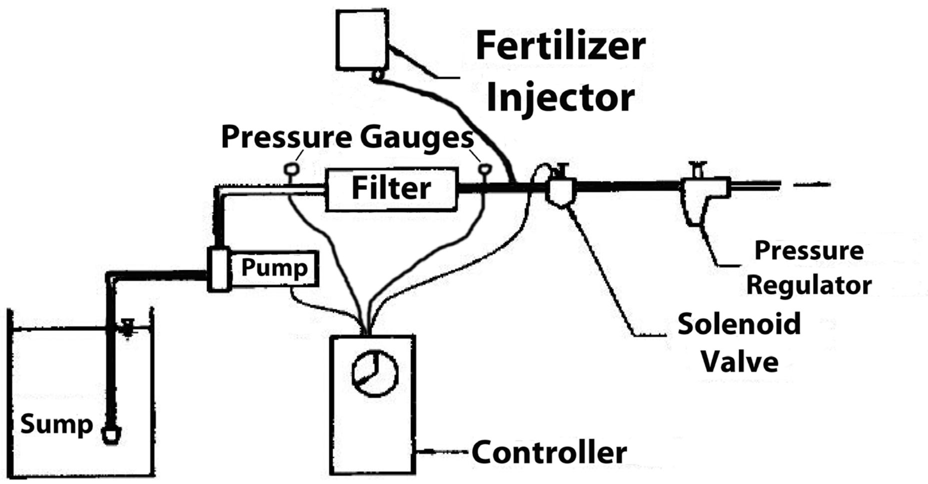

Figure 1: Typical micro-sprinkler irrigation system "head." Controller can detect differences between inlet and outlet pressure and activate automatic filter back flush systems.

Each sprinkler manufacturer specifies a minimum mesh size or filtration needed for each of their particular sprinklers in order to minimize wear on sprinkler and maximize sprinkler efficiency.

Micro-sprinkler irrigation systems operate at relatively low pressure compared to large sprinkler irrigation systems (e.g. handset sprinklers). For this reason, pumping costs are substantially less. A pressure regulator is used to control the line pressure as sprinklers have a maximum operating pressure for optimal efficiency. Multiple pressure regulators may be desirable for locations with large elevation changes, as pressure increases with elevation drops. Small diameter polyethylene pipe (1/2 to 1 inch) is generally used for the in-row laterals that are laid on the soil surface with risers or suspended on wire and T-posts in the tree row with drop down sprinklers nozzles, typically sprinklers are connected to the poly pipe with spaghetti tubing. Irrigation lines are buried between rows to facilitate tractor operations. The lateral is connected to a manifold that is supplied with water through a main and/or sub-main connection. Manifolds, sub-mains and mains are usually buried with control valves either above or below ground.

The purpose of the lateral is to supply water to sprinklers located in the tree row and the lateral should be sized for the maximum flow rate of water application. Sprinklers are chosen for flow rate at the tree but are dependent on lateral pressure to perform correctly. Sprinkler manufacturers specify minimum and maximum pressure ranges to maximize system efficiency for each sprinkler. Once sprinklers are selected and installed, lateral pressure is controlled by a pressure regulator valve to match sprinkler size and capacity. It is important that all sprinklers being fed from a common lateral are selected for the same pressure. Sprinkler dealers can size and design complete sprinkler irrigation systems for the exact needs of your orchard and your water supply.

System Management

Micro-sprinkler irrigation can be configured in one of two ways; with either drop down sprinklers from suspended irrigation lines or risers mounted on stakes from surface irrigation lines. Both methods connect sprinklers to in-row irrigation lines with 'spaghetti' tubing. Drop down sprinklers allow for mowing between trees since no moving of sprinklers is required to mow, unlike with riser mounted sprinklers. Micro-irrigation systems are also useful and suitable for sloping or irregularly-shaped pieces of land that are otherwise impractical to furrow irrigate.

Micro-sprinkler systems usually have a sprinkler between every other tree and are staggered (offset by one tree) in adjoining tree rows to maximize irrigation coverage and efficiency, and minimize costs. The size of the sprinkler emitter, or orifice and working pressure, determines application rate. Maximum application rates are in turn dependent on soil characteristics such soil texture and maximum water infiltration rates for given soils, so as not to apply water at a faster rate than the soil can absorb in a given time. When irrigation water contains sediment, typically ditch or reservoir water, micro-sprinkler systems usually make use of an in-line filter system to prevent emitter clogging and reduce wear (detailed above).

Micro-irrigation systems can apply water on a short-set, high-frequency basis, optimal for younger trees with a smaller root mass, or long-set, lower frequency irrigations to providing a more consistent and optimal soil moisture environment for mature trees, depending on your particular orchard and water supply situation. Soil moisture monitoring devices, such as composite gypsum blocks or Watermark™ sensors, can help improve overall irrigation system performance by allowing the irrigator to monitor and manage soil moisture more conveniently and accurately. Consult with your local Extension office for guidance on installing and reading soil moisture sensors for your soil type; typically maximum soil moisture depletion for fruit trees is 30 to 40 KPa[2] of soil vacuum during flowering and 50 to 60 KPa[2] post flowering until the fruit sizing stage where maximum soil moisture depletion returns to 30 KPa[2]. Where uninterrupted water delivery is available, micro-sprinkler systems can be setup to operate irrigations automatically, triggered on and off by the same soil moisture monitoring devices.

Since micro-sprinkler irrigation systems apply water in a manner that can be very precise at meeting your crops water needs, it is recommended that irrigators practice the 'water balance approach' regardless of irrigation frequency. The water balance approach involves calculating the daily water use by the crop (ET) and replenishing it on an as needed basis depending on soil water holding capacity and the orchard's age, top soil depth, rooting depth, and water availability schedule. For example, if you have water available every 8 days and the daily ET is 0.3 inches, you would apply 2.4 inches of water to refill your soil profile (water balance approach). Even if soil moisture sensors are in place, the water balance approach is a good tool for monitoring the condition of the tree/root/water system and the accuracy of sensors. The water balance approach is described in Extension fact sheet 4.707, *Irrigation Scheduling: The Water Balance Approach*. The crop (ET) concept is described in fact sheet 4.715, *Crop Water Use and Growth Stages*. Different water management methods are also described in fact sheet 4.708, *Irrigation Scheduling*. Basically, the 'water balance approach' starts the irrigation season with a soil profile at maximum water holding capacity and replaces the water used by the trees (transpiration) and the water lost by evaporation into the atmosphere from the ground surface, at each irrigation. Daily ET amounts are calculated and posted daily for your specific area at the COAGMET website: http://ccc.atmos.colostate.edu/cgi-bin/stationsum_form.pl, to help in calculating irrigation amounts for the water balance approach.

Soil and Water Quality

If your orchard has been diagnosed with high salt levels, this can be mitigated by leaching (pushing with excess water) salts below the tree root zone. You should consult your local Extension specialist before attempting any large scale leaching as leaching done incorrectly or at the wrong time can worsen your salt situation. Irrigation water with high pH also impairs the trees' ability to absorb key micro-nutrients such as iron, zinc and manganese, but high soil and/or water pH can be neutralized by the injection of acid into the irrigation water with a fertilizer injector in order to lower irrigation water and soil pH and induce a more healthy growing environment for the trees, you should consult with your local Extension agent about these practices. In western Colorado's tree fruit growing areas, irrigation water pH typically starts at approximately pH = 7.6 at the beginning of the growing season and increases to a high of pH = 8.3 near harvest, due to increasing carbonate levels in the irrigation water. The pH of the soil tends towards the pH of the irrigation water, so irrigating with high pH water can in and of itself increases soil pH, which in turn reduces micro-nutrient availability to trees (mentioned above). All orchardist should know the pH of their orchard soils and actively work to lowering and maintaining soil pH at levels of pH = 7.4 or less, to optimize micro-nutrient availability in our alkaline soils. Lowering the soil pH to less than pH = 7.4 is not economically practical in the short-term due to the high rate of free lime in area soils.

More on irrigation water quality is described in Extension fact sheet 0.506, *Irrigation Water Quality Criteria* and on salinity in Extension fact sheet 0.521, *Diagnosing Saline and Sodic Soil Problems*.

In all fruit growing areas of western Colorado, there may be cost-sharing money available to install a micro-sprinkler irrigation system (consult with your local NRCS or Conservation District staff).

Fertilizer injection or 'fertigation' is also possible with micro-sprinklers but is highly dependent on soil type and if cover crops are already providing some of the tree nutrients. Cover crops grown in the orchard alleyways have the potential to reduce erosion, keep orchard temperatures cooler thereby reducing overall ET and may supply much of the orchard's required fertility depending on the species mix.

Healthy soils and good water quality are integral parts of a productive orchard and successful micro-sprinkler irrigation management program. Soil and water testing are the best tools for determining if there are salinity, pH or nutrient problems present in your orchard or irrigation water. For more information on soil and water testing refer to Extension fact sheet 0.520, *Selecting an Analytical Laboratory*.