



WOBBLER® TECHNOLOGY

Irrigating Orchards and Groves



IRRIGATING FRUIT AND NUT TREES

Full, instantaneous coverage helps accelerate growth of young trees and brings them into production faster.

The amount of water orchard trees need varies with size, climatic conditions, and other factors, but overall, the water used by trees is remarkably similar between species. The main goal of any irrigation system for orchards is to ensure maximum growth in the trees' early years, which promotes healthy root development and maximum production of adequately sized crops.

Source: http://homeorchard.ucanr.edu/The_Big_Picture/Irrigation/

To achieve this goal, irrigators can rely on Wobbler® technology to distribute water with maximum uniformity over a large area of coverage, wetting the entire root zone. Most importantly, these multi-functional sprinklers can do more than just irrigate. Orchard trees need protection from frost damage, excess salinity in the soil, and cooling during hot dry months. With Wobbler sprinklers, one product can be adapted to fill these multiple needs and applications. Simple modifications like adjusting riser height and spacing are all that's needed.

Benefits of Senninger Wobbler Sprinklers

- ① Low pressure irrigation
- ② Droplets that resist wind-drift and evaporative loss
- ③ Instantaneous application is ideal for frost protection
- ④ Uniform application ensures salt does not accumulate in pockets
- ⑤ Fewer laterals, less clogging and lower maintenance requirements

Designing a System

One important goal of a well-designed orchard irrigation system is to achieve the highest uniformity possible while considering spacing restrictions, tree density, wind conditions, operating pressure and application rate to best meet the needs of your crop. To avoid coverage problems caused by wind-drift and high tree density, always select spacings with 90% or more overlap.

See WinSIPP™3 design software (pg 10) for precise installation recommendations.

PEACH-BRAZIL

Xcel-Wobbler™ sprinklers were installed in a triangular pattern at 39 x 39 ft (12x12 m) at 20 psi (1.38 bar) in this orchard. This installation is used primarily for frost protection and helped reduce water consumption during frost events by 21 gph (80 L/hr) per each individual sprinkler head for a total savings of 36,984 gph (140,000 L/hr) each night.







MULTI-FUNCTIONAL SYSTEMS

Senninger sprinklers can provide a controlled rain with high uniformity in all types of terrain and contours. For orchard irrigators, this means that one system can be used to:

- ① Protect against frost damage
- ② Cooling crops
- ③ Leach excess salt in the soil
- ④ Chemigation

FROST PROTECTION

Low temperatures and freezing conditions present a great threat to crop growth and could result in partial or total losses if not handled appropriately. Overhead irrigation can provide the highest level of protection when compared to a vast majority of currently available systems. It is also one of the most economical frost control alternatives.

The sprinkler system's energy consumption is considerably less than what growers normally would spend with heaters and other electrical equipment. The labor requirements are less when compared to these other methods and it is relatively non-polluting.

Frost protection depends on the principal of heat fusion to maintain plant temperature at or near 32° F (0° C). Essentially, as the air temperature surrounding the plants drops below freezing levels, the water begins to freeze and crystalize, releasing approximately 80 calories of heat for every 0.035 ounces (1 gram) of water that freezes. As the ice encases the plant it partially insulates it from the harsh exterior temperatures. Sprinklers provide a 2 to 5° (-16.7° to -15°C) temperature difference, which is just enough to protect the plants. As long as water is constantly wetting the plant, the system should successfully protect them from severe damage.

The ice should appear relatively clear. If there is a clear liquid-ice mixture coating the plants and water is dripping off the ice, then the application rate is sufficient to prevent damage. If the water freezes and has a milky white appearance, then the application rate is too low for the weather conditions.* Thus, the water application must be much more uniform than required for irrigation so that no area receives less than the designated amount.

Wobbler sprinklers gently apply a consistent and uniform layer of water over plants to keep them covered in ice at all times. This prevents sudden loss of heat. The droplets produced by these sprinklers are consistently sized and large enough to resist wind drift – thereby preserving the pattern's integrity – but gentle enough to prevent damage to plants. Their constant rotary action also prevents ice buildup and prevents the sprinkler from freezing. In addition, less water is needed for achieving an equal result when compared to stream-driven devices.**

Source: *The ABC's of Frost Management* by Robert G. Evans (2008)

* For best results, Senninger recommends the use of weather tools, such as psychrometers. Weather tools can alert orchard managers of upcoming frost events and help managers better prepare.

**This document is intended only as a reference tool for typical application considerations and may not apply to all systems or conditions. The information is supplied upon the condition that the persons receiving same will make their own determination as to its suitability for their purposes prior to use. In no event will Senninger be responsible for damages of any nature whatsoever resulting from the use of or reliance upon information from this document or the products to which the information refers.



CACAO - ECUADOR

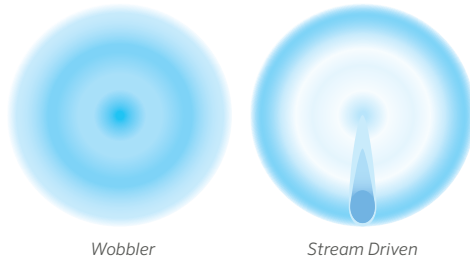
This cacao orchard uses the Xcel-Wobbler™ for irrigation. These sprinklers are installed in a rectangular pattern at 29.5 x 29.5 ft (9 x 9 m) with an operating pressure of 25 psi (1.72 bar), and a flow rate of 1.67 gpm (381 l/hr). Growers found the Xcel-Wobbler can give them uniformities of over 88% while lowering their system's operating costs thanks to the sprinkler's low-pressure operation. This particular installation delivers an average application rate of 0.2 in/hr (5.2 mm/hr).



FULL COVERAGE AT A LOW APPLICATION RATE

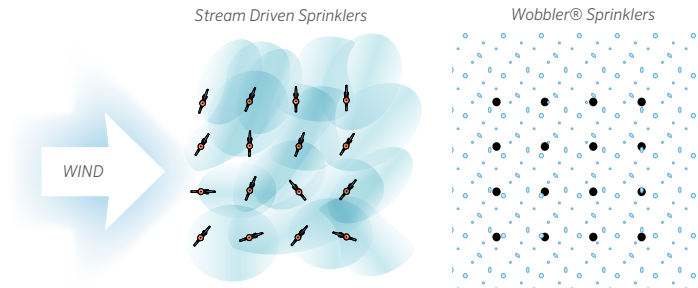
Senninger sprinklers use their unique design to distribute water over a large area, at a low application rate. When water is spread over a large area the soil can slowly absorb the rain-like distribution at a comfortable rate. This means the chance of ponding and developing pockets of severe salt build up is greatly reduced while soil infiltration rates are preserved.

Distribution Pattern



DROPLET SIZE

Sprinklers need to distribute water in a pattern that maintains their integrity in wind conditions. This is essential for achieving high irrigation uniformity and reducing water and energy consumption. To achieve this goal, sprinklers need to distribute water in adequately sized and relatively uniform droplets. Small droplets are easily affected by the wind, which means their spray pattern can be distorted. But Senninger's Wobblers® sprinklers distribute water in larger droplets less prone to wind-drift and evaporative loss. This allows them to distribute water with up to 95% uniformity while remaining gentle enough for delicate fruits and nuts.



OVERTREE COOLING

Small amounts of water applied throughout several short cycle irrigation events can lower crop temperature and raise the humidity of the air as the water evaporates. This reduces the water loss by transpiration. In addition, cooling can improve fruit color and quality, and prevent solar injury.

Irrigation-cooling is more effective if the application is uniform, which is why Senninger sprinklers are ideal for this application. A uniform application can fully wet the surfaces that need to be cooled such as fruit, leaves and limbs. Systems that concentrate their streams in a smaller area are unable to prevent sun injury or ease crop stress.

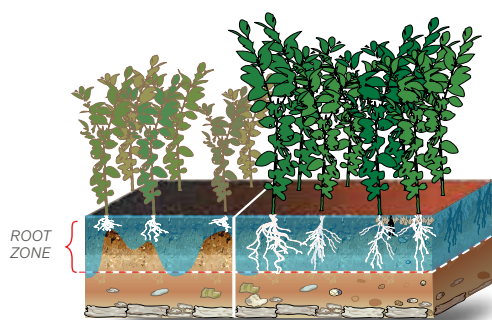
SALT LEACHING

Salts are added to the soil with each irrigation but a uniform application ensures salt does not accumulate in pockets across a field. When the build-up of soluble salts in the soil becomes excessive, the concentration of salts can be minimized by uniformly applying more water than needed by the crop during the growing season. Water will move the salts downward, through and below the root zone.

Senninger sprinklers are ideal applicators for leaching salts. Their instantaneous and uniform pattern can help prevent the formation of salt pockets while letting the soil absorb the water at a rate it can handle. Other irrigation methods, such as localized irrigation systems can leave salt close to the crop and root zone, usually at the edge of the wetted pattern. Deep percolation can be attempted with these systems, but they still tend to leave substantial amounts of salt in the soil.

INSECT CONTROL

The ability to spread water and chemicals from above and/or below the foliage area at low pressures and with high uniformity can be useful for insect control. In some cases, it is important to provide an application of insecticide over entire orchard in order to control some fast-moving insects. The injection of pesticide into overhead sprinkler system would allow to do it with ease.



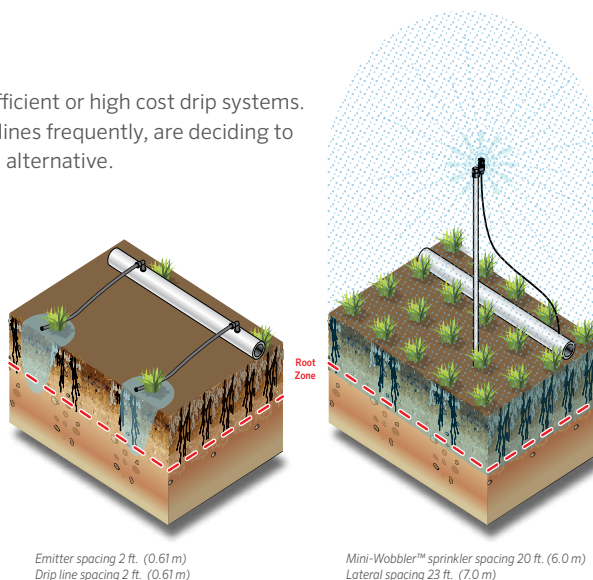
ROOT DEVELOPMENT

Uneven crop is usually the result of a lack of irrigation uniformity. Other irrigation systems concentrate water over a small area so root development may be restricted by the limited area wetted. While these systems are adequate during the first three years of tree growth, older trees have larger and more extensive root systems that benefit from sprinkler irrigation. Roots normally extend far beyond the branch tips, so the application pattern of a sprinkler can easily deliver water to the entire root zone. This helps mature trees improve their yield, fruit sizing, and tree vigor.

COMPLEMENT OR REPLACE DRIP

Low energy sprinklers have long complemented and/or replaced inefficient or high cost drip systems. Many irrigators who have installed drip systems and need to replace lines frequently, are deciding to install sprinkler irrigation as a more durable, efficient and economical alternative.

- **Cost** – Sprinklers require fewer laterals for operation and can even be installed in existing drip systems after some design adaptations.
- **System Monitoring** – Sprinklers are more visible, making it easier to assess performance.
- **Clogging** – Sprinklers' larger nozzle orifice sizes are less prone to clogging and don't require as careful attention to filtration.
- **Multiple Applications** – Drip systems cannot be used for frost protection, salt leaching or adequate germination.





The mini-Wobbler and Xcel-Wobbler sprinklers use Senninger's off-center rotary action Wobbler® technology. It provides extremely uniform coverage over a large diameter at low pressures.

MINI-WOBBLER™



Flows: 0.42 to 2.18 gpm (95 to 495 L/hr) Operating
 Pressure: 15 to 25 psi (1.03 to 1.72 bar)
 Diameters: 26.5 to 53.0 ft (8.1 to 16.2 m)
 Connection: ½" M NPT
 High-Angle and Standard-Angle models available

XCEL-WOBBLER™



Flows: 0.78 to 6.97 gpm (177 to 1583 L/hr)
 Operating Pressure: 10 to 25 psi (0.69 to 1.72 bar)
 Diameters: 32 to 55.5 ft (9.8 to 16.9 m)
 Connections: ½" or ¾" M NPT
 High-Angle and Mid-Angle models available

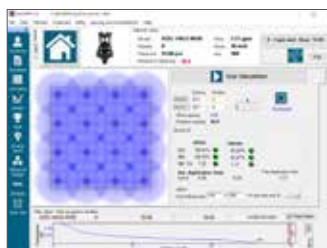
DESIGNING A SYSTEM

Sprinklers are designed for overlapping coverage. Efficient spacing begins with an understanding of water distribution.

Sprinklers are designed to irrigate at specific flow rates and reach certain diameters of coverage. To obtain maximum efficiency avoid over or under watering, the system design must work within the sprinkler manufacturer's parameters. The application rate of these overlapping sprinklers can be tailored to your soil and crop needs.

WINSIPP™3

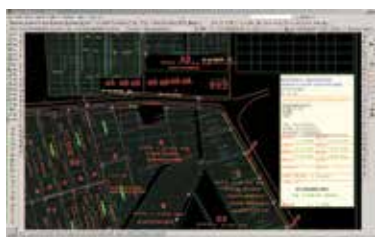
WinSIPP™3 compares different spacings, sprinkler models, nozzle sizes, riser heights, and operating pressures to determine which sprinkler and system design would be best for your specific application.



- ① Test the application uniformity of sprinkler layouts before a system is installed
- ② Determine optimal sprinkler spacing
- ③ Render system designs to see specifics on flow, velocity and pressures along manifolds in lateral lines
- ④ Obtain visuals of the coefficient of uniformity, distribution uniformity, and the scheduling coefficient

IRRI-MAKER™ AND IRRI EXPRESS™

Irri-Maker and IrriExpress let you design comprehensive irrigation projects ranging from large-scale agricultural designs to small-scale landscape designs. Both programs let users evaluate installation alternatives in advance, survey any terrain, produce a contour plan, draw the details, and apply the irrigation design.



Features

- ① All in one software package: combines surveyed data, CAD, DigitalTerrain Modeling (DTM) and irrigation calculation functions
- ② Conduct quick and comprehensive analysis of hydraulics
- ③ Generates contour plans and 3D images illustrating the irrigation design in relation to slopes and elevations
- ④ Calculate hydraulics, pressures, flows and quantities. Automatically update the pump pressure and pipe sizes as necessary
- ⑤ Assign shifts in the irrigation design to conserve power and cost



RISERS



Senninger's Riser Stake is available in either 26" or 14" length models to support the Senninger Riser Adapter for use with a $\frac{1}{2}$ " M NPT connection sprinkler or spray nozzle. It can also be used for direct mounting a barbed base sprinkler into 0.25", 0.270", or 8 mm tubing.

Riser Adapters make irrigating easier in hard to reach places and are ideal for temporary and portable systems. Riser Adapters are connected to the laterals allowing the sprinklers on each to be repositioned as needed.

- No gluing or fusing required
- Multiple fittings, bushings and tapers available for 0.345" and 0.270" PE tubing
- Suitable for sprinkler with a $\frac{1}{2}$ " M NPT connection
- Riser adapter suitable for the 14" or 26" Riser Stakes as well as $\frac{1}{2}$ " PVC, $\frac{3}{4}$ " PVC, or $\frac{5}{16}$ " steel rod

QUICK CONNECT COUPLING

TWO PIECE HOUSING THAT LOCKS TIGHTLY



Quick-Connect couplings help reduce material costs for irrigation systems. By connecting small diameter pipes, laterals become easier to transport. This is ideal for high rotation crops and field work.

PRESSURE REGULATORS



Pressure regulators assure applicators operate properly. Uncontrolled pressure fluctuations can result in unwanted flow deviations or over/under-watering. These fluctuations occur with activation of different zones, variations in field elevation, or changes in water supply. Pressure regulators are available in a variety of models to match specific flow and pressure needs.



Senninger's commitment to world-class products, local support and technical expertise ensure we provide the most efficient and reliable agricultural irrigation solutions available in the world today.

A handwritten signature in white ink, reading "S. D. Abernethy".

Stephen D. Abernethy, President of Senninger Irrigation