Senninger®

WOBBLER® TECHNOLOGY

Frost Protection

FRUITS, NUTS AND ORNAMENTALS

Ultra-low temperatures can cause ice to form inside plant tissue, injuring plant cells and often killing and ripening fruit. That is why frost control methods are crucial for protecting crops like fruits, nuts, and ornamentals to help ensure a successful yield.

There are two main types of frost protection, the passive and active method. The site selection, plant nutritional management, and proper pruning are just a few of the passive techniques implemented before a frost night to avoid the need for active protection. Active protection methods include heaters, wind machines, sprinklers, and more.

Overhead irrigation is used to protect low-growing crops and deciduous fruit trees with strong scaffold branches that do not break under the weight of ice loading.

Overhead irrigation provides the highest level of protection compared to most available systems. It is also one of the most economical frost protection alternatives. Sprinkler systems have lower operational costs than heaters and other electrical equipment. Plus, they are relatively non-polluting.

Sprinklers like the Xcel-Wobbler™ and mini-Wobbler™ use less water than conventional impact sprinklers, making them an even more efficient solution for frost protection.

Source: Frost Protection: Fundamentals, Practice, and Economics by the Food and Agriculture Organization of the United Nations

System Requirements

Ideally, over-plant sprinklers for frost protection should re-apply water constantly over the entire plant to help ensure that the area receives a sufficient application rate to prevent the plant tissue from losing heat energy and possible plant damage. For frost protection, sources suggest a minimum coefficient of uniformity (CU) of 80%.

This means the water application needs to be much more uniform than what's required for irrigation so that no area receives less than the designated amount.

Application rate requirements for overhead sprinklers are different based on the sprinkler type, wind speed, minimum temperature, and crop type. As long as there is a liquid-ice mixture on the plants, with the water dripping off the icicles, the coated plant parts will be protected.

Factors to Consider

1. Forecasting the minimum temperature and how it might change during the night is key to deciding if protection is needed and when to start the system
2. Verify the system before an expected frost event
3. Turn on the system when the wet-bulb temperature is higher than the critical damage temperature*
4. Ensure water is applied continuously
5. Don't shut down the system too early. Even if the sun is shining on the plants and the air temperature is above 32°F (0°C), sprinklers should not be turned off unless the wet-bulb temperature measured upwind from the crop is above the critical damage temperature*
6. Consider investing in a backup power source
7. Consult with local extension service for recommended precipitation rate based on the crop

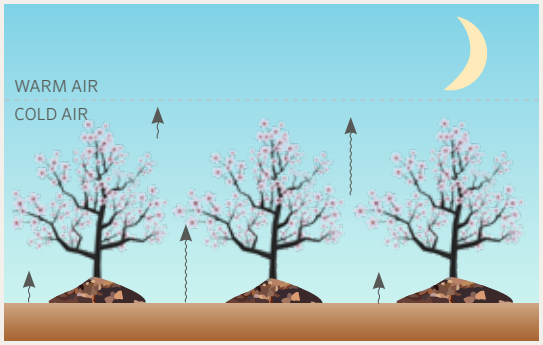
Sources: The ABCs of Frost Management by Robert G. Evans, USDA Agricultural Research Service, 2009.
**For detailed information about start-up and shut-down temperatures, see chapter 2, table 2.2 of Frost Protection Fundamentals, Practice, and Economics by the Food and Agriculture Organization of the United Nations, Volume 1.*

OVERHEAD IRRIGATION

Frost protection with sprinklers depends on the principle of latent heat to maintain plant temperature at or near 32° F (0° C).

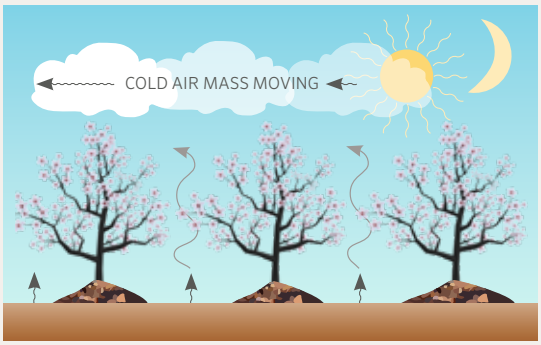
As the air temperature drops below freezing levels, the water applied by the sprinklers begins to freeze and crystallize on leaves, branches, and buds.
As the water cools down, it releases 80 calories of heat energy for every 0.04 ounces (1 gram) of water that freezes. The heat energy lost by the water is then transferred to the plant. As the ice encases the plant, it partially insulates it from the harsh exterior temperatures.

Sprinklers provide a 35.6 to 41° F (2 to 5°C) temperature difference, which is just enough to protect plants. As long as water is constantly wetting the plant, the system should successfully protect them from severe damage.



Radiation Frost

Radiation frosts are common occurrences. They are characterized by clear skies, little wind, temperature inversion, and low dew-point temperatures. Active protection methods can be effective in fighting radiation frost.



Advection Frost

Advection frosts are characterized by cloudy conditions, moderate to high winds, no temperature inversion, and low humidity. The rapid cold air movement robs the plants of their heat.

WRONG

If the water freezes and has a milky white and compact appearance, then the application rate is too low. The water is freezing too fast and trapping air inside the ice.

CORRECT

If the water freezes and has a clear liquid-ice mixture appearance with water dripping off the ice, the system is working properly. The application rate is enough to prevent damage.

Source: The ABCs of Frost Management by Robert G. Evans, USDA Agricultural Research Service, 2009.

WOBBLER® TECHNOLOGY

Senninger Wobbler sprinklers distribute water with exceptionally high uniformity over a wide area. Their instantaneous 360° distribution pattern, low operating pressure and wind resistant pattern make them one of the most effective sprinklers to combat frost damage.

Wobbler Benefits

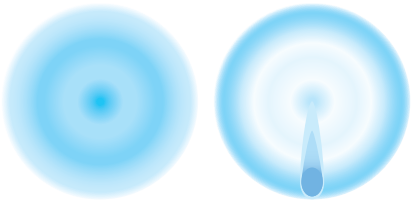
① Irrigate with ultra-low pressures of 10 to 25 psi (0.69 to 1.72 bar)
② Water droplets resist wind-drift and evaporative loss
③ Instantaneous full-circle application wets plants at all times
④ Constant rotary action prevents ice buildup
⑤ Fewer laterals, less clogging and lower maintenance requirements

CONSTANT ROTATION

Wobbler sprinklers apply an instantaneous and uniform layer of water over plants that keeps them covered in ice at all times. Their thermoplastic construction and constant rotary action helps prevent ice build-up on the sprinkler so they remain operational.

In contrast, stream driven sprinklers wet a smaller area at a time and can take 60 to 120 seconds to make a full circuit. Additionally, their metal components can cause them to freeze and stop.

DISTRIBUTION PATTERN



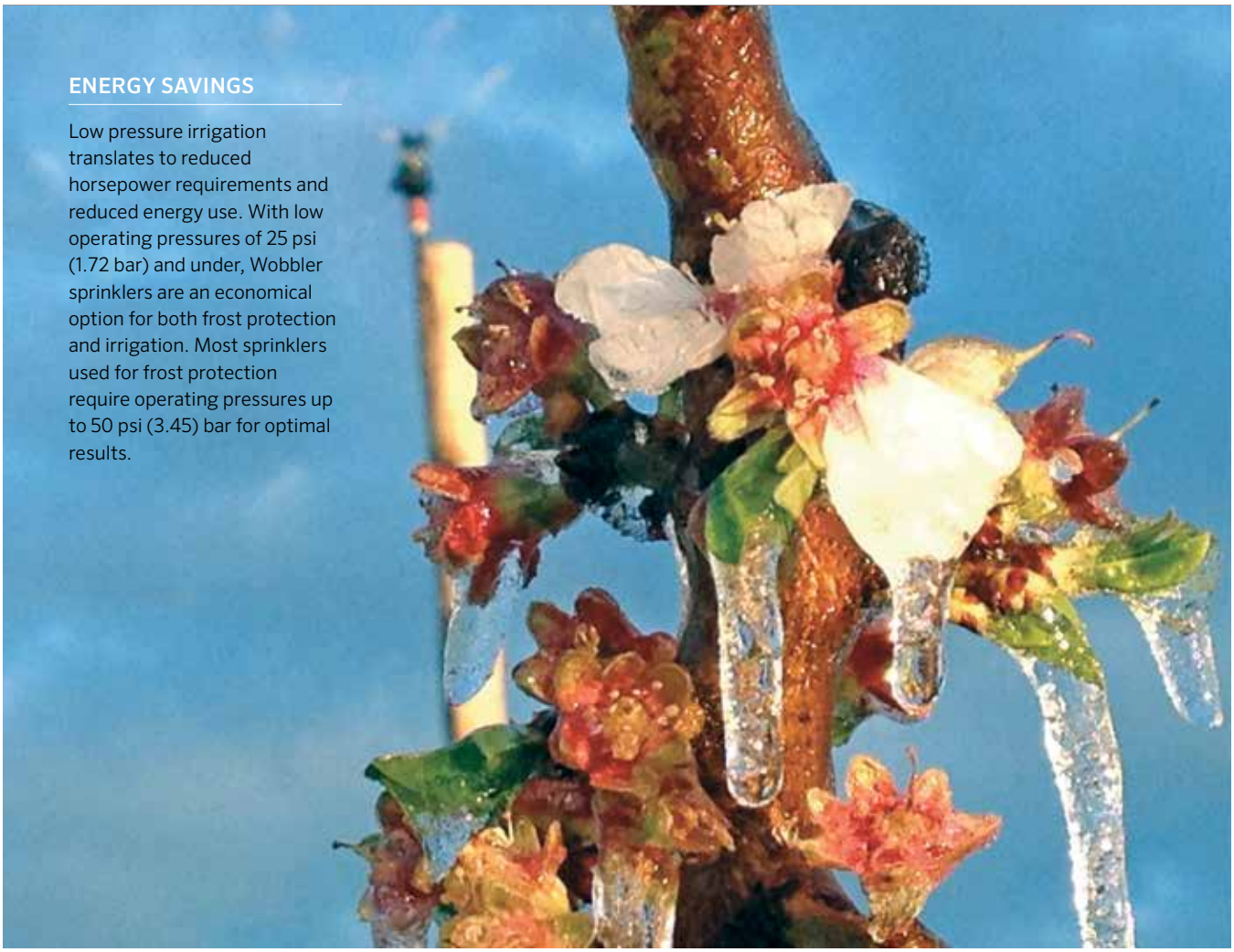
Wobbler Sprinklers *Stream Driven Sprinklers*

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 43 ft (8.1 to 13.3 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



ENERGY SAVINGS

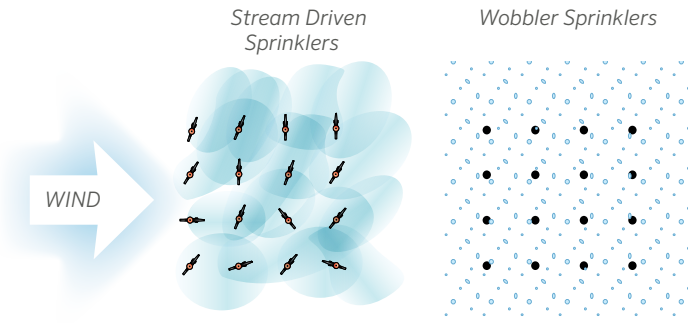
Low pressure irrigation translates to reduced horsepower requirements and reduced energy use. With low operating pressures of 25 psi (1.72 bar) and under, Wobbler sprinklers are an economical option for both frost protection and irrigation. Most sprinklers used for frost protection require operating pressures up to 50 psi (3.45) bar for optimal results.

ENERGY COST - ELECTRIC DRIVEN PUMP						
Sprinkler	Cost per psi	Multiply	Pressure (psi)	Equals	Annual cost	5 Year cost
Xcel-Wobbler	$16.00	x	15	=	$240	$1,200
Impact Sprinkler	$16.00	x	50	=	$800	$4,000
SAVINGS					**$560**	**$2,800**

Based on energy cost of $0.08/kWh and system flow rate 182 m³/hr (800 gpm) . Annual run time 1,000 hours. The savings of an individual grower vary depending on your specific system, hours of operation, desired flow rate and pressure, energy source and energy costs.

DROPLET SIZE

Sprinklers need to distribute water in a pattern that maintains their integrity in wind conditions. This is essential for reducing water and energy consumption. Wobbler sprinklers distribute water in larger droplets less prone to wind-drift and evaporative loss. This allows them to irrigate with up to 95% uniformity while remaining gentle enough for delicate tree branches.



1 CHERRIES IN CURICÓ, CHILE

Xcel-Wobbler™ sprinklers successfully protected these cherry trees, completely freezing the tree branches and encapsulating the crop under a thin layer of ice. Two months later, the crop successfully went through the flowering process and fruit formation without showing signs of frost damage.

Site Details		System Details	
Crop	Cherries	Product	Xcel-Wobbler
Location	Guaico Farm in Curicó, Chile	Operating Pressure	20 psi (1.38 bar)
Size	74 acres (30 hectares)	Application Rate	0.13 in/hr (3.4 mm/hr)
Minimum Temperature	21° F (-6° C)	Spacing	33 x 33 ft (10 x 10 m)

2 APPLE ORCHARD IN STYRIA, AUSTRIA

Farmsolutions is a professional irrigation system design company in Eastern Styria. They have been installing Xcel-Wobbler™ sprinklers in frost protection systems for nearly 5 years. The extremely high uniformity of the Xcel-Wobbler has helped customers reduce their water usage during frost events by around 20% when compared to impact sprinklers. The sprinkler's low operating pressure has also helped their customers reduce pumping costs.

Site Details		System Details	
Crop	Apples	Product	Xcel-Wobbler
Location	Eastern Styria, Austria	Operating Pressure	25 psi (1.72 bar)
Size	5 acres (2 hectares)	Application Rate	1.68 gpm (382 L/hr)
Minimum Temperature	21° F (-6° C)	Spacing	30 x 30 ft (8 x 9.9 m)

3 WOODY ORNAMENTALS IN EUSTIS, FLORIDA USA

The Xcel-Wobbler™ sprinklers used for irrigation also serve for frost protection for woody ornamentals in North Central Florida. Jon's Nursery began using the Senninger Wobbler in the early 1980's. Jon learned of their frost protection capabilities during the freeze of 1983, when the sprinklers ran overnight and saved almost all his plants.

Site Details		System Details	
Crop	Woody Ornamentals	Product	Xcel-Wobbler
Location	Jon's Nursery in Eustis, FL	Operating Pressure	35 psi (2.41 bar)
Size	200 acres (81 hectares)	Application Rate	0.17 in/hr (4.3 mm/hr)
Minimum Temperature	20° F (-6.7° C)	Spacing	23 x 30 ft (7 x 9.1 m)

4 BLUEBERRIES IN HAWTHORNE, FLORIDA USA

Xcel-Wobbler™ sprinklers now irrigate and provide frost protection for blueberry plants in North Florida, replacing brass impacts. During a recent freeze event, the temperature was in the mid to lower 20's °F (around -5 °C) with double-digit wind speeds. Blueberries under the impact sprinklers were lost while almost all fruits under the Xcel-Wobbler were saved.

Site Details		System Details	
Crop	Blueberries	Product	Xcel-Wobbler
Location	Hawthorne, Florida	Operating Pressure	25 psi (1.72 bar)
Size	81 acres (200 hectares)	Application Rate	0.3 in/hr (7.6 mm/hr)
Minimum Temperature	20° F (-6.7° C)	Spacing	30 x 30 ft (9.1 x 9.1 m)

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. Senninger will not 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.

Senninger®

The Senninger 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.

Stephen D. Abernethy, President of Senninger Irrigation

Website senninger.com | **Customer Support** 407-877-5655
13505 Granville Ave., Clermont, FL 34711

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